Electrical Review

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLII. No. 11. NEW YORK, SATURDAY, MARCH 14, 1903. ISSUED WEEKLY

ELECTRICAL REVIEW

13 to 21 Park Row *NEW YORK*

BY THE

ELECTRICAL REVIEW PUBLISHING COMPANY

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TELEPHONE CALL (private branch exchange connecting all departments) — "21 Cortlandt."

REGISTERED CABLE ADDRESS — "Electview," New York.

SUBSCRIPTIONS

One Year, United States and Canada	$3.00
One Year, Foreign Countries	5.00
Single Copies, each	10
Copies supplied for only one year back, each	25

TO ADVERTISERS

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

ELECTRIC FANS.

The time is approaching when the electric fan will again resume its labor of relieving suffering humanity, and there are few inventions which bring more comfort to the world's workers than this little appliance. Although the fan itself is a small thing, the fan business is a large and important one. There are few offices which make any pretensions to comfort in which at least one, probably two or more, electric fans are not to be found, and the load produced on the supply station in this way must be considered. In one of the large New York office buildings it is frequently necessary on a hot day to stop one of the elevators because of the overload produced by the fans in the building. Fans can be secured now to satisfy all tastes and all pocketbooks, and it must be a small business indeed which will not warrant the comfort which is brought by the installation of one of these little machines.

RENTING MOTORS.

In introducing a new method or apparatus, some inducement must be offered to the user or purchaser to persuade him to discard the old in favor of the new. This has been particularly true in the electrical industries, and though many schemes have been suggested and tried, even yet one frequently hears under debate the question whether the central station should furnish incandescent lamps to its customers or whether the latter should be required to purchase their renewals. In some cases, and particularly in Great Britain, the electrical supply company wires the houses free of charge in order to secure custom. This, of course, means that the supply company must employ larger capital and charge higher rates for its output.

Motors Rented by the Central Stations.

An interesting case of this kind is pointed out by J. S. Highfield in a paper which he read before a recent meeting of the Manchester section of the British Institution of Electrical Engineers. At St. Helen's, the electrical supply company is operating about 500 horse-power of motors, costing, approximately, $14,000. These motors are, in general, hired out, this action being necessary to induce the users to install motors in place of the old steam machinery. While they might be willing to concede the advantages of electrical driving, they are not always willing to discard the old machinery and invest the necessary capital to secure the new. The rental paid for these motors is about fifteen per cent of the cost, which, in addition to the income from the power supplied, would seem to make a fair return to the central station for its outlay.

Small Cost for Repairs.

Another point of interest brought out in this paper was the small cost of repairs for motors. For the last year this was only $75 for the motors, although they were, in many cases, installed in not very suitable or clean positions. It was not stated how long these motors had been in service, but, in any case, this is a creditable record.

EFFECT OF TEMPERATURE ON PERMANENT MAGNETS.

The permanent magnet has always been a source of wonder to the non-scientific and the subject of much study and theorizing to the physicist. Nevertheless, it is a fact that our knowledge of this important phenomenon is all too limited. A study of all phases of magnetism is essential in electrical engineering, and for this reason a recent article by Mr. H. B. Loomis, appearing in the current issue of the *American Journal of Science,* on "The Effects of Changes of Temperature on Permanent Magnets," is valuable.

Scope of the Work.

Mr. Loomis has studied two effects of temperature: First, change in the magnetic moment, and, second, change in distribution of magnetism with the temperature. His results show that in the first case the proportional change in magnetic moment, due to change in temperature, is greater for short than for long magnets, and that a magnet having a greater intensity of magnetization suffers less proportional change. In the second case he has found that the proportional change in distribution of magnetism, due to change in temperature, is greatest at the ends and least in the middle of the magnet.

Explanation of Results.

To explain these results the author makes use of Ewing's addition to Webber's theory of magnetism, which assumes that the forces which hold the little molecular magnets in position are largely the mutual attractions and repulsions of these molecular magnets among themselves. If this assumption be accepted, it would seem that the molecular magnets near the end

of the bar would be held in position by forces less in amount than those acting upon the molecules nearer the centre of the magnet, and, therefore, the end would be more affected by temperature changes than points nearer the centre of the magnet.

Desirable Extension of This Study.

These results were obtained from studies of small bar magnets, a type of magnet which finds but little practical application. It would seem that a thorough investigation of the effect of temperature upon larger permanent magnets of the types so much used in electrical measuring instruments would result in some valuable information. The resultant effect of temperature upon measuring instruments has been given a great deal of study; but would it not be better to separate the different effects and investigate each of these by itself? In this way the behavior of the instrument would be more thoroughly understood, and the data secured would probably indicate the proper method of correcting for temperature. A study of commercial types of permanent magnets would seem to be a suitable topic for a thesis in electrical engineering.

THE NEW DRESS.

It is with just pride that we point to the changes in makeup which have been incorporated in recent issues of the current volume of the ELECTRICAL REVIEW.

While the function of a technical journal is to reflect accurately the advance of that branch of science for which it stands, and to propagate and promulgate those ideas which will enhance this advancement, it should also frame its service in an attractive garnishment.

Easy reading is a help to thoughtful reading, and that combination of typographical effects which, while enlightening, is also restful, is greatly to be desired. The mechanical preparation of this journal has always been along those lines which would result in symmetrical balancing of responsibility and good appearance. A careful study of this art has resulted in the dignified and handsome issues which have created for us an eminent place in technical journalism.

Taking up these changes more in detail—the black-face running titles and head-letter have been discarded, and in their stead a light-face, clean-cut letter of the same character as the body letter has been used. The department headings have been rearranged and refined to an appearance of utmost simplicity. The editorial columns have been enriched and enlivened by the addition of sub-titles, keying the meat of each suggestion; and the news department has been remodeled, the old three-column page giving way to a more readily digested and appreciated arrangement.

THE HORSE AND THE AUTOMOBILE.

The relative value of our old friend, the horse, and our newer servant, the automobile, is a topic which excites a great deal of interest at this time. We hear friends of the former scoffing at the possibility of our being able to replace this faithful and patient animal by a mere machine. For certain kinds of work, they say, the automobile may come into fairly wide use, but it will never become as popular nor as widely used as the horse. Possibly in city work, where heavy trucks are to be hauled for short distances, the automobile may gain a foothold. At present, these lovers of the horse hold that the automobile is merely a fad—a toy for those who have money and time to spend; and that it will be laid aside as soon as some new plaything, such, for instance, as a practical flying machine, is invented.

Claims for the Automobile.

On the other hand, the automobilists hold that the horse is doomed, and that the automobile is better in every way. It can do more work in less time, and at a less cost, than can be done in the old way. They lay stress upon the desirability of excluding all horses from cities, and they claim for the automobile many other advantages over the horse.

Sentimental Side of the Controversy.

Another phase of the question is brought out by our esteemed contemporary, the New York *Evening Sun.* This paper believes that the horse is too popular and too well loved to be displaced easily, and points out that there are times when travel by the more easily controlled horse is desirable. In driving an automobile, both hands are required for its control.

It would seem that the editor of the *Sun* has never learned to ride a bicycle nor traveled in an automobile. He says that you can't talk to the bicycle. Our experience has been that there is nothing —except, perhaps, the game of golf— which is so provocative of picturesque and highly tinted expression, and few things are more exasperating than an automobile that won't "mote." We recommend to our contemporary Jerome's "Three Men on Two Wheels," as this will shed some light upon this phase of the discussion.

Neither Extreme View Correct.

For ourselves, we do not hold either of the extreme views expressed above. That the automobile will replace the horse in a great many cases we think can not be disputed. It will, in fact, emancipate him from all hard labor. But horses will certainly be kept by many people, both for light service and for love of this noble animal. The dog is still popular, although the number of them that do any work is quite small. It may be in ages to come that a small breed of horses will be developed, just as has been the case with dogs. The Lapland pony would doubtless be a good breed to start from for this purpose.

Automobiles May Be Made Sociable.

If those who have been accustomed to driving horses balk at the automobile because they can not talk to it, it will be entirely feasible to place a dummy horse in front of the vehicle, which will move its legs, and even wag its ears when spoken to. We can even go further if it seems desirable, and equip the noble animal with a phonograph so that it can take part in its master's conversation. So far as we know, no horse has yet been educated up to this point. The objection that one can not talk to an automobile would seem, therefore, to fall to the ground.

The Work for the Automobile.

But to the automobile will surely fall all the hard labor, both in city and in country. It is not affected by weather, and will work just as rapidly and quickly and as long with the temperature at one hundred and ten as when it is only fifty. It is less trouble to care for, and less fickle in its behavior. The only thing it does insist upon is good roads, and in this demand it has the support of all drivers, both of horses and automobiles.

ENGINEERING SOCIETIES.

Doubtless all will admit the desirability of cooperation among the various engineering societies, but differences of opinion may exist as to the most desirable method of securing this. Suggestions have been made for a general engineering society, of which all engineers might become members, in addition to belonging to that society which is distinctive of that particular branch of the profession in which the work of each lies.

Drawbacks to a General Engineering Society.

An objection which might be urged against this plan has been suggested by the conflicting claims of those societies which already exist. It is, of course, desirable that all of these should have a full membership in order that they may secure the advantages accruing to large societies. Large and well-organized bodies of workers can secure advantages which can not be obtained by organizations of small numbers. Now, no society can have a full membership if it excludes the younger members of the profession, a fact well brought out by the present active canvass which is being carried on by the American Institute of Electrical Engineers among the young men. It can not be denied that the membership dues, light as they may appear to older members, in many cases prove a serious stumbling block in the path of the young man who is just entering on his active practice. It would seem, therefore, that a general engineering society could count upon only the older engineers as members. This hardly seems desirable, for if the separate societies benefit by large membership, the same rule would hold for the general society. Moreover, at the present time, if the young man is not tied down to work of a very narrow character, it often seems desirable for him to belong to more than one society; but he can hardly be expected to help support three, which would be the case if he found it necessary to join the general engineering society, too.

Overlapping of Work.

There is occasionally some overlapping in the work of the various organizations, but it has not been of a very serious character in this country, although it is true it has been so abroad. However, this overlapping may become more serious in the future, as the various lines of engineering work call upon each other more and more for assistance. This overlapping, of course, could be prevented if there was but one engineering society, with sections devoted to the various branches; but this is practically out of the question, as no one of the present societies would be willing to place itself under the control of another body. Nor, indeed, would it appear desirable for it to do so, for each organization represents a certain class of work, and its policy is best framed by those familiar with its aims and limitations. Although at present a member of any engineering society is always welcome at meetings of another; he is not always informed when topics of interest to him will be presented at such meetings, and it is therefore probable that he misses much that would be of benefit to him.

Local Societies.

Another phase of the subject which should not be overlooked is that, in many cases, a local organization which is justified in giving time and attention to matters of purely local interest often seems desirable, and these bodies would probably exist entirely independent of the main society.

An Engineering Building.

A plan has been suggested for bringing the engineering societies which already exist into closer touch and which deserves consideration, is the erection of a building to be occupied by all of them. The suggestion, coming when certain of these societies are without adequate quarters, and are, indeed, looking around for suitable accommodations, seems to make the present a propitious time for its consideration. The plan could be carried out in several ways. The various organizations could unite and build a structure suitable to the dignity and importance of the profession. This plan, however, seems to present some difficulties in carrying out. A plan suggested by one of our contemporaries seems feasible. This is that an organization be formed, entirely independent of the governing boards of the societies, and this organization erect an engineering building, having the assurance that the engineering societies will occupy this as their headquarters. To lighten the expense, this building might provide offices, which would prove very desirable to engineers. This building should have large auditoriums, rooms for the several libraries, and such other accommodations as might be necessary. It would not be difficult to arrange the schedule so that there would be no conflict between the several societies. There would be brought under one roof the finest technical library in the world, and this would be free to all members. And there would be other advantages which are not any less important. Engineers of different branches would come in contact, and each would profit by the acquaintance. This intercourse would tend to broaden the views of each, and by bringing about a better understanding of the aims of each, would also tend to lessen friction and misunderstandings.

Dignity of the Profession Requires Suitable Building.

The importance of the engineering professions has been generally recognized in recent years. They are now classed among the learned professions, and a system of technical schools has grown up which probably makes engineers the best-trained and best-educated class of workers in the world. But with the increasing responsibilities should come increasing influence, and this can be secured only by a thorough understanding among the different branches. Would not an engineering building promote this?

An Engineering Building Would Not Interfere with Other Plans.

It is true that by following this plan there might be more difficulty in securing united action than if a general engineering body existed, but a general organization would make a common building desirable. If, after the experience gained from the common use of a building, a common organization seems necessary, nothing will have been done which will interfere with its formation. Although one of the national societies has a very fine home, it would certainly give this up readily when shown that it would benefit thereby.

ELECTRICAL MINING NOTES—I.

BY SIDNEY F. WALKER.

WHAT ELECTRICITY IS USED FOR IN BRITISH COLLIERIES.

In addition to coal cutting, electricity is used in British collieries for signaling, telephoning and for driving pumps, haulage plant, and to a smaller extent for driving winding drums, fans, and for lighting.

Perhaps it may be as well to describe what coal mines are like, in order that engineers who are not familiar with them may fully understand the problems which have to be solved. Coal seams lie in irregular sheets, in the bottoms of what were once the beds of lakes, the beds having been filled up with detritus from the rivers which poured into the lakes, vegetation having then sprung up on the soil so formed, the vegetation having died and been buried by further deposits of soil, etc., and in some cases having again formed the beds of a lake, which again was filled up and so on. The contour of the coal field is like that of an irregular basin, the coal seams forming layers on top of each other, but separated by other strata like layers of paste in a pudding basin. The main fact to remember in connection with the coal fields of the United Kingdom is that each seam outcrops, as it is termed, one each side of the basin, and sometimes all round it. That is to say, the coal seams can be found on the edge of the basins, showing at the surface, when the vegetation is cut away, and from these points the seams gradually slope down to the bottoms of the basins where they are appropriately horizontal for certain distance, and then climb the other side. The coal fields are often cut up in addition by upheavals caused by volcanic action, so that the seams are broken up more or less by what are termed faults, and their contour is often also very much altered by the same agency. Thus in some coal fields there are two lesser basins, forming parts of what was evidently a large basin, the division having been formed by an upheaval, called an anticlinal, which forms the ridge of one side of each basin.

The coal seams are got by either driving what are called levels, or drifts in this country, tunnels in America, where the seam can be reached by this means; that is where it is near the outcrop, and by shafts where the seams are lower. Levels may often be seen running into the sides of hills, meeting the coal seams as they approach the surface.

In either case the coal is cut away from its position between other strata by the means described in the article on coal cutting, and the lumps of coal are filled into mine wagons, called trams in this country, wooden or steel boxes on wheels running on rails, and are then hauled to the shaft bottom, or to the mouth of the level, the means employed now being almost universally mechanical haulage, though horse haulage survives to a certain extent, especially in what is termed secondary haulage. This is one of the uses of electricity to work the different haulage systems. The arrangements will be described later on.

Coal mines are also very often troubled with large quantities of water. Water is stored in certain forms of rock, such as sandstone, gravel, chalk, which absorb water just as a sponge does, and as these rocks usually lie at an inclination with the vertical, and outcrop to the surface, just as the coal measures do, and as also the rain water which is deposited upon those portions of the rocks which are exposed on the surface of the ground falls by gravity through the rocks, and again escapes wherever an opening occurs, as when the rock itself is tapped, and these rocks are often tapped by the workings, the store of water finds its way into the coal mine and has to be pumped to the surface, and this is the second and perhaps the most important use to which electricity has been applied in British collieries. This will be more fully dealt with later on. As the whole of a coal mine is situated underground, and as men and horses have to live a portion of their lives in the mines, it is necessary that a continuous supply of fresh air shall be provided throughout the mine. This forms another use for electricity, as will again be explained.

Also when the coal has been brought to the shaft bottom, it has to be lifted to the surface. Also it often happens that it is convenient, where two or more seams are worked together from one set of shafts, that the coal shall all be hauled along the roads of one seam, and to allow of that being done the coal from the lower seam is sometimes lifted to the upper seam through a small shaft some distance in the workings.

It will be understood also that light is wanted underground at all times, and at night also on the surface, and this is the remaining use of electricity in bulk in British collieries.

PUMPING BY ELECTRICITY.

The water in a coal mine may be dealt with in two principal ways, and the choice is usually determined by the conditions under which the mine has to work. Thus, if the mine is situated on the syncline, as it is termed, near the centre and bottom of the basin, the water is led, if possible, to large tanks near the shaft bottom, from which it is pumped to the surface. Sometimes it not possible to do this, and the water is led to ponds or tanks at convenient points, as much as the nature of the strata will allow, and from there it is pumped to the shaft bottom. Where the shafts are on the inclined portion of the basin it is usual, if it can be done, to sink them on the upper edge of the "royalty," as it is called, the area that is to be worked at that colliery, and to run out roads from the shaft bottoms, following the inclination of the seam and descending with it. This is called working to the dip, and is a very favorite method with mining engineers, as it saves very considerably in the cost of shafts, and enables them to get into the market with coal at an earlier date than would otherwise be possible. Shafts form one of the largest portions of the cost of opening out a colliery. In some cases, however, it is not possible to arrange for working to the dip. The ground may not be available for sinking shafts at the upper edge of "the royalty," or from other causes the shafts may have to be sunk either in the middle or at the bottom of the area to be worked. In those cases the water from the workings "to the rise," the workings which are at a higher level than the shafts, falls by gravity into tanks near the shaft bottom. Where working to the dip rules, the water follows the inclination of the working, and the pumps which are used to raise the water from the dip-workings have to be arranged to follow the workings down. Perhaps the most important and most popular use of electricity in British mines is for driving dip-pumps. No method is so convenient nor so efficient as an electrically driven pump for this purpose. The pump itself with the necessary speed-reducing gear and the electric motor are mounted together on one carriage. The carriage which is sometimes made of wood, but more frequently now of iron, is mounted on small truck wheels of the same gauge as the rails which are used for the haulage roads of the mine, and the whole is placed on the rails and allowed to follow the water as it recedes in front of the pump, the electric cables and the delivery pipes of the pump being lengthened as the whole apparatus descends. There are a very large number of arrangements for running dip-pumps by electric motors. In some cases the two

are geared directly together with merely a second motion shaft between, supported by the common bed-plate or by the pump casting. In other cases a longer bed is used, and a belt or ropes, only a portion of the reduction of speed being done by the gear-wheels. At least one of the gear-wheels is now always of buffalo hide, or some similar substance, something which will give slightly when the pump is first started, so as to relieve the strain upon the parts engaged in the mechanical transmission between the motor shaft and the mass of water in the pipes connected to the pumps. The matter of the cables is also better dealt with by having drums attached to the carriage of sufficient capacity to allow the motor to go as far as it will be required without jointing. Joints in cables in a coal mine are frequent sources of trouble, especially where there is water, as it is so difficult to exclude the water from the joint before it is covered up, and it is also very difficult to cover the joint effectually under the conditions. Even if second or third drums have to be added it is better than making joints at every forward move of the pump. The fewer the joints the better. One of the great troubles in connection with electrically driven pumps is the matter of the starting resistance. In the early days of electrically driven pumps, especially where they were fixed some distance in the workings, it was not unusual to dispense with starting resistance altogether, making the resistance of the cables themselves sufficiently large to prevent the passage of very heavy currents on starting, and allowing the motor to work inefficiently in order to get rid of the constant trouble with burnt-out starting resistances and starting switches. In those days starting switches and resistances were made far too small, and the resistances were frequently allowed to remain in circuit. Now those about the collieries where dip-pumps are at work have learned more about the matter, and makers have also learned to make their apparatus stronger. In too many instances, however, even now, the starting apparatus is too small for the work. Another trouble which has been felt in connection with dip-pumps has been the inequality in the load. At first, series-wound motors were used with all electrically driven pumps. But it often happens that a particular district in a mine only makes a certain quantity of water in the twenty-four hours, which can be pumped out in a few hours' run. When the pump is first started the load is comparatively heavy, and the motor runs comparatively slow. As the pump gets the water under, however, the load lightens and the motor runs faster. This causes the load to be lightened still more quickly, and the motor to run still faster, till toward the end of the run the motor may be going at a dangerous speed. The shunt-wound motor, on the other hand, does not give sufficient starting torque for the load it has to deal with in the inert column of water in front of the pump. The difficulty has been got over by using shunt-wound motors with a few turns of series winding added, outside the shunt windings, to give the necessary starting torque. The shunt-wound motor does not run away with a light load. In many cases the attempt has been made, and in some collieries with success, to run the pump from a distance. The starting switch is worked from the power-house by an electromagnetic arrangement, and the current is cut off at the power-house when it is known that all the water has been pumped out. In these cases, and with ordinary pumping by electricity, attempts have been made to fix no-load and overload releasing apparatus so that in the event of the pump losing its water, or of a hot bearing, the motor will stop automatically. These have not been as successful as under somewhat similar conditions on the surface, owing to the fact that the electromagnets of the releasing apparatus are always partly wound with fine wire, and the fine wire nearly always either breaks off on the inside or is eaten off by the moisture which is nearly always present.

For dip-pumping, the pump almost universally employed is the three-throw ram pump. It consists of practically three ram pumps with their cranks set 120 degrees apart.

For driving the large pumps, which are used to force the water from the tanks near the shaft bottoms to the surface, the arrangements are somewhat similar, but the pumps are fixed, with their motors, in a substantial pump house in a convenient position, the pumps and motors being placed upon solid foundations, and the mechanical transmission from the motor to the pump being usually by ropes. The electric pump house near the bottom of a large colliery is exactly like the engine house on the surface, the pumps taking the place of the driving engines, and proper switchboards being provided. In the early days of pumping by electricity, and up till very recently, the motors were all worked by continuous currents supplied from a 500-volt, continuous-current generator on the surface. In many collieries this is the rule now, but there is a power-house where several continuous-current generators are running very much as in a power supply or electric lighting station. The continuous current is, however, giving way to three-phase, the motors being so much handier and so much less trouble.

Tomassi's New Accumulator.

Messieur M. D. Tomassi has brought out an accumulator which has some novel features. The plates are of the pasted type, the lead grid being divided into rectangular compartments and having ribs running alternately, vertically and horizontally in these compartments. The object of this arrangement is to stiffen the plate and thus prevent buckling. Each section is perforated at the centre to allow free circulation of the electrolyte. Each plate has a diagonal lead rib intended to conduct the current from all points directly to the terminal. The following give the constants of a small cell of this type:

Number of plates, 5; number of positive plates, 2; length of plates in millimetres, 140; width of the plates in millimetres, 140; thickness of the plates in millimetres, 3; total weight in grammes, 2,000; total weight of two positives and two negatives, 1,600; duration of discharge in hours, 5; mean useful voltage, 1.9; output in amperes, 6; output in amperes per kilogramme of plates, 3.8; capacity in ampere-hours, 2.8; capacity in ampere-hours per kilogramme of plate, 17.75; power in watts, 11.4; watts per kilogramme of plate, 7.1; energy in watt-hours, 54.15; energy in watt-hours per kilogramme of plate, 33.7.

At a rate of one ampere per kilogramme of plate the capacity is about 36 ampere-hours, or 25 ampere-hours utilizable per kilogramme of plate.

Automatically Tuning Electric Circuits.

At the recent meeting of the American Association for the Advancement of Science, Professor Carl Kinsley described a method of automatically tuning electric circuits. An electric circuit can be tuned to any frequency within a wide range by varying its self-induction. This may be accomplished automatically by using a moving core in the coil. If the spring-held core is slightly beyond the position of resonance in the direction of too large self-induction, it will be retained in equilibrium between the force of the spring and the pull of the coil. The plunger will, therefore, rise and fall in the coil as the varying frequency requires a greater or less self-induction for resonance. Charts were used showing the operation of the method.

THE BEDELL SYSTEM OF COMPOSITE TRANSMISSION.

BY A. S. McALLISTER.

The problem of selecting the equipment for rendering available at one point electrical energy transmitted from power supplied in the mechanical state at a distant location involves a study of the characteristics of the electric generators, transmission circuits and receiving apparatus. Excluding from the present discussion the requirements of the electrolytic industries, it may be stated that in general there are two classes of receivers to be supplied with power, the lamps and the motors each possessing characteristics distinctly different from the other.

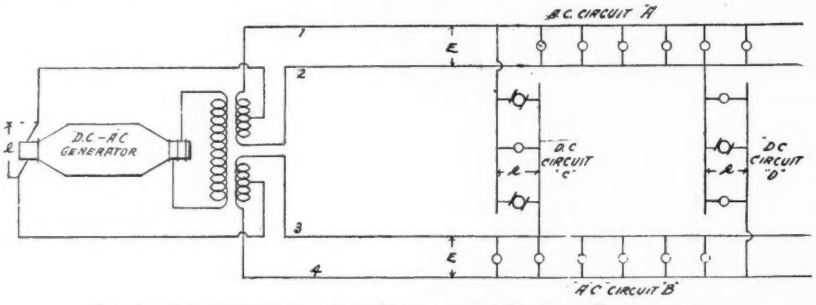


FIG. 1.—DIRECT-CURRENT AND ALTERNATING-CURRENT DISTRIBUTION—COMMON CONDUCTOR SYSTEM.

The nature of the filaments of incandescent lamps dictates that they be operated at a relatively low voltage, while economy in conducting material necessitates a high electromotive force for the motors. Though a change of a few per cent in the electromotive force affects only slightly the operation of the motors, even a relatively small fluctuation in the electromotive force at the lamp terminals renders the lighting service quite unsatisfactory. The lamps, operating at practically unity power-factor, in themselves cause very little fluctuation in the electromotive force. Motors, however, especially when of the induction type, produce an excessive change in the circuit electromotive force when thrown into and out of service. The lighting load is essentially single-phase, while motors render best service only when operated polyphase.

The present day power circuits are universally of the polyphase type, which fact requires that the single-phase lighting load be distributed among the separate phases. Any inequality in the division of the loads on the polyphase circuit results in an unsymmetrical relation of the electromotive forces which renders impossible the perfect regulation of the voltage at the lamps without the use of apparatus specially designed for that purpose, even though, as is customary on account of the different characteristics of the two classes of receivers, separate circuits be installed for the lamps and for the motors.

The difficulties attendant upon designing a commutator which will give satisfactory service upon a synchronous converter for supplying power to standard traction motors, when the frequency is high, is well appreciated by all engineers. The desirability of selecting a low frequency for the best operation in parallel of alternators and synchronous motors and for the least reactance drop in the transmission line, due to any lagging current demanded by the receivers, is as well known. In numerous installations, however, the frequency has been placed at a high value, dictated by the requirements of the lamps, greatly to the detriment of the power service and of the regulation of the circuit electromotive force.

There can be no doubt that were the service wholly one for mechanical power,

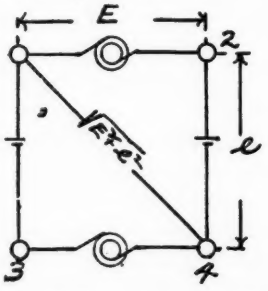


FIG. 2.—DIRECT-CURRENT AND ALTERNATING-CURRENT ELECTROMOTIVE FORCES.

a low frequency polyphase system would be chosen, while if the only load were that due to the lamps the selection would be a single-phase system operated at a high frequency.

According to a discovery made by Dr. Frederick Bedell, it is possible to transmit simultaneously the low-frequency polyphase current and the high-frequency single-phase current, using only such amount of conducting material as is demanded by one system alone, while the regulation of each component system of the composite transmission is entirely unaffected by any load of whatsoever value or character on the other.

When alternating currents of different frequencies are superposed in a conductor the resultant current is equal to the square root of the sum of the squares of the separate currents. This leads to the interesting and important result that each current produces the same effect as though it traversed the conductor alone.

Let I and i be two currents of different frequencies, the resultant current is $\sqrt{I^2 + i^2}$, and the loss in a conductor of resistance R is $I^2R + i^2R$, which shows that the loss due to each current is unaffected by the presence of the other current. When the two currents are equal in value the amount of conducting material necessary for transmitting at a certain loss is only one-half of that required for a current equal in value to the sum of the individual currents. The loss for a current 2 I will be 4 I^2R, and for the composite current will be 2 I^2R, or the conducting material for the former current must be twice that for the latter.

Fig. 1 shows one method of connecting circuits for distribution on the common-conductor system. The generator supplies alternating current to circuits A and B, and direct current to circuits C and D. A moment's inspection of the diagram will show that loads on the two alternating-current circuits will have no effect on the electromotive force at the direct-current receivers. With reference to the direct-current load it will be observed that any current which flows in one direction through one-half of one transformer coil returns in the opposite direction through a half of another coil on the same core, so that the current has no magnetizing effect on the transformer core, which fact, coupled with that of the non-interference of the two currents in the conductors, renders the regulation of the two circuits quite independent one of the other.

The electromotive forces of the alternating and of the direct-current circuits can be placed at values suitable for the corresponding receivers. Thus, all motors can most conveniently and economically be operated by direct current at moderate voltage from circuits C and D, while lamps of proper electromotive force can be connected to any of the four possible circuits.

By the installation of the common-conductor system motor service may be offered without any additional cost for conducting material where by the present

methods only lamp service can be economically maintained. Consider a single-phase equipment supplying power for lighting service. In order to double the capacity of the distributing circuits it is necessary to increase by 100 per cent the conducting material. This is accomplished by installing a separate circuit and satisfactory service is secured. Now by the simple expedient of introducing direct current at proper neutral points, power equal in amount to that being utilized may be transmitted to motors, or other direct-current apparatus, without producing any effect whatever upon the alternating-current receiver. The economical area of distribution may thus be extended into territories too remote from the generating station to justify the expense of circuits for one class of service alone.

It is worthy of note that no new or untried apparatus is needed for the composite distribution, the generating, transmitting and receiving equipment being of standard design.

The economy inherent in the three-wire system of distribution for lighting circuits may be obtained without diminution in the composite system, since the receivers may be connected three-wire per circuit without complications.

When direct and alternating currents, or alternating currents of different frequencies, are superposed, not only is the resultant current larger than either of the components, but the resultant electromotive force is also raised, the increase in each case being as though the two components were added in quadrature. Thus, if I and i be the two currents, and E and e the two electromotive forces, the resultant current will be $\sqrt{I^2 + i^2}$ and the resultant electromotive force $\sqrt{E^2 + e^2}$. (See Fig. 2.) The power transmitted will be $EI + e\,i$ which, when $\frac{I}{i} = \frac{E}{e}$, is equal to $\sqrt{I^2 + i^2}\ \sqrt{E^2 + e^2}$. Which means that the resultant voltage is of a value such as would be necessary in a single-phase (or two-phase) system to transmit the total power at the resultant value of the current.

In any installation using the composite system for distribution, each individual receiver will be subjected to the electromotive force intended for its circuit alone, so that the increase in the value of the resultant electromotive force does not necessitate a higher electromotive force at the receivers, the outcome being that there is obtained the efficiency incident to transmitting at an electromotive force of $\sqrt{E^2 + e^2}$, and the convenience of receiving at an electromotive force E or e without transformers. For low-tension distribution where there is placed an economical limit to the receiver voltage, as in the circuits for incandescent lamps, this characteristic of the composite system allows of a saving as great as fifty

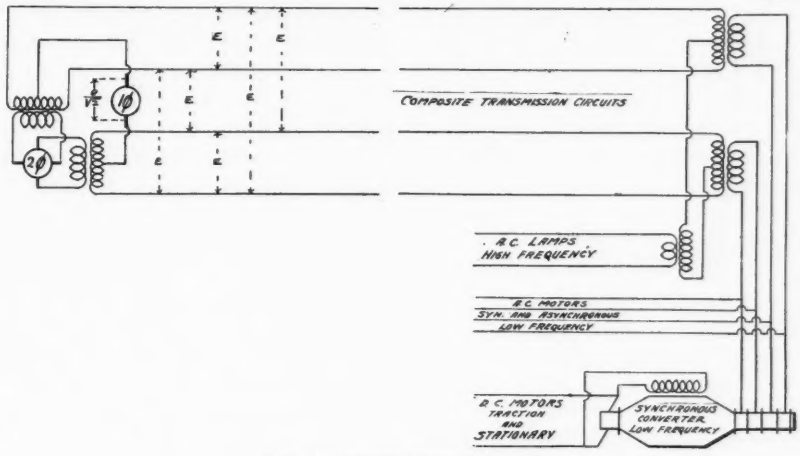


FIG. 4.—GENERATING STATION.
1φ—Single-Phase Low-Frequency Generator.
2φ—Polyphase High-Frequency Generator.

per cent in the cost of conducting material.

In the case of high-tension transmission circuits the electromotive force between lines is the basis upon which is founded the determination of the relative economies of various systems. Obviously, therefore, it is desirable so to introduce the superposed electromotive force that the resultant electromotive force between lines is not raised. An investigation of the two-phase system with separate circuits having inter-

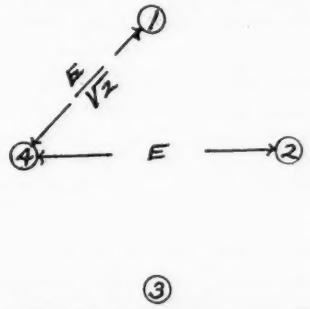


FIG. 3.—TWO-PHASE ELECTROMOTIVE FORCES.

connected neutral points, reveals the fact that the electromotive force between opposite phase lines is less than that between wires of the same phase. Hence, there may be connected between the neutral points of the two phases an electromotive force of a value such that the resultant composite voltage is equal to that between the lines without raising the circuit electromotive force.

Consider a two-phase circuit having an electromotive force of E volts per phase (Fig. 3). The electromotive force between wires of opposite phases with the separate neutral points connected together will be $\sqrt{\frac{1}{2}}\,E$. It is now desired to introduce between the neutral points of the separate phases an electromotive force of different frequency of such a value that the voltage between opposite phase lines will be E, which is seen to be the maximum measurable electromotive force. Since any superposed asynchronous electromotive force will add to the previously existing electromotive force, as though in quadrature, the required electromotive force is

$$[E^2 - (\sqrt{\tfrac{1}{2}}\,E)^2]^{\frac{1}{2}} = \sqrt{\tfrac{1}{2}}\,E.$$

Hence, in general, it may be stated that the interposed electromotive force must have a value equal to that normally existing between opposite phase lines.

In order to determine the relative economy of the composite transmission, and the transmission by single, two and three-phase systems, assume in the first place two-phase circuits.

Let R = resistance of each wire,
I = current per wire,
then $4\ I^2R$ = total line loss,
and $2\ IE$ = energy transmitted.

Since the electromotive force of the interposed single-phase circuit is $\sqrt{\frac{1}{2}}\,E$, and the resistance of the outgoing or incoming conductor is $\frac{R}{2}$ (see Fig. 4), in order that the percentage loss in the single-phase circuit may be the same as that in the two-phase, the single-phase current, i, must have a value such that

$$\frac{i^2\,R}{i\,\sqrt{\frac{1}{2}}\,E} = \frac{4\ I^2R}{2\ IE} \text{ or } i = 2\,\sqrt{\tfrac{1}{2}}\,I,$$

and the single-phase energy is $2\,\sqrt{\frac{1}{2}}\,I$, $\sqrt{\frac{1}{2}}\,E = 1E$ or fifty per cent of the two-phase energy. The composite system will therefore transmit 150 per cent as much energy as the two-phase system alone on the basis of equality of maxi-

mum measurable electromotive force and of equal percentage loss of energy in the line.

On the basis of 100 per cent copper for the two-phase system there will therefore be required conducting material as follows:

Phases.	Conducting Material.
1	100.00
2	100.00
3	75.00
Composite	66.66

The significance of these figures will be better appreciated if application be made to a practical service equipment. Consider a three-phase system, now installed, operating under the most favorable conditions for power service—that is, at a low-circuit frequency. It carries its full load with a line loss of five per cent of the energy transmitted. By the erection of an additional wire similar to each of the other three, there may be transmitted over the two-phase circuits the same amount of energy with the same line loss as before, and by the composite system of connection an amount of single-phase energy at high frequency equal to fifty per cent of the polyphase energy at an independent line loss of five per cent. Thus, by an increase of thirty-three and one-third per cent in conducting material the power capable of being transmitted has been increased fifty per cent.

The increased economy of conducting material, while quite satisfactory in itself, is of secondary importance to the independence of the regulation of the electromotive force of the lamp and motor circuits as secured by the composite system.

Fig. 4 is a diagrammatic representation of composite transmission circuits just described. As will be seen, there is introduced between the neutral points of the two phases of the low frequency polyphase system a single-phase electromotive force of value $\sqrt{\frac{1}{2}}\,E$, where E is the electromotive force per phase of the low-frequency circuit, so that the resultant voltage between any two wires is the same throughout. Any single-phase current passes differentially through each half of the transformer coils, and, therefore, produces no effect whatever upon the core magnetism, and, as shown previously, the current in the transmission wires do not interfere one with the other. The single-phase circuit may be overloaded even to the degree of short-circuit, and no effect will be observed upon the polyphase system.

A fair idea of the entire independence of the regulation of each circuit of the composite system may be formed from the fact experimentally verified, that when telephonic sets are substituted for the single-phase generators and lowering transformers, no audible effect is produced in the receivers when a load of any value or character is thrown upon the polyphase system, and that conversation under such condition of connections may be carried on with satisfactory results. This appears the more remarkable when it is remembered that the power necessary to produce an audible sound in a telephone receiver is an almost inconceivably small fraction of a watt.

The problem which has long been the subject of almost endless discussions in engineering circles seems at last satisfactorily to have been solved by a method, the most prominent characteristic of which is its entire simplicity.

An Electrically Worked Canal Lift.

The swing bridges over the River Weaver at Northwich, England, have for some time been worked electrically with such success that the Weaver navigation authorities have decided upon equipping the Anderton lift, where the Shropshire Union Canal joins the Weaver, with electrical plant. By this conversion one man in the switch house will be able to control all the necessary movements, whereas hitherto eight men have been necessary to work the lifts. The electrical plant to be supplied comprises two motors for working directly the lock gates at the end of the Shropshire Union Canal, which is 70 feet above the level of the Weaver; one motor on each of the pontoons controlling by means of ropes the lock gates at either end, and one motor in the engine house directly connected to a variable stroke pump to supply water under pressure of 700 pounds per square inch to the rams. The two vertical cylinders of the hydraulic lifts are connected, so that as one pontoon sinks it forces up the other; an additional supply of water under pressure is, however, necessary to overcome friction and any difference in weight between the two pontoons.

Bulletin of the University of Minnesota.

Bulletin No. 5 of the University of Minnesota relates to the college of engineering and mechanical arts of that institution. Descriptions of the grounds, buildings and equipments are given, with a synopsis of the work offered in each department. The department of electrical engineering has recently secured a new building, affording ample facilities for work in all branches of this subject.

AN ELECTRIC CAR LIGHTING SYSTEM.

BY W. L. BLISS.

(Concluded.)

REGULATING THE GENERATOR FOR VARYING TRAIN SPEEDS.

Third—It is desirable to have the generator develop its normal voltage, equal to that of the battery, at as low a speed as possible, consistent with economic design, in order that the electrical energy developed by the generator may be available during as long a proportion of the car's travel as possible. In this system, using thirty-two cells of battery having a normal voltage of sixty-four volts, the generator is so designed and so geared to the axle that, when running at 500 revolutions per minute corresponding with a train speed of about twenty miles per hour, it generates sixty-four volts. If, now, the train should increase its speed until it reached about sixty miles per hour, the armature of the generator would be making about 1,500 revolutions per minute. All other conditions remaining the same, the voltage of the generator would, of course, be proportional to its speed, and hence the voltage at its terminals would rise to about 192 volts. As a matter of fact it will be sufficient to have the generator increase its voltage to eighty volts at maximum speed, as this will be approximately 2.5 volts per cell, which is ample to force the full charging current through the battery. If the generator voltage is not in some way prevented from rising above the predetermined value of eighty volts, great overloading of the generator, batteries and wires will result. In fact, such increase must be positively prevented, and the provision of means therefor constitute one of the distinctive features of this system.

The method of regulation consists in generating, by independent means, a counter-electromotive force in the field circuit of the generator, which increases in proportion to its speed and voltage, and hence reduces the field current of the generator, and prevents excessive output. The details of this arrangement are described under the heading of the bucker and its operation.

CONSTANT LAMP VOLTAGE.

Fourth—As above pointed out, the fundamental object of the storage battery is to maintain the supply of electrical energy for the lamps whenever the generator is inoperative. Hence it is customary to keep the lighting mains permanently connected to the terminals of the battery. (A hand switch placed in these mains serves to connect the lamps

with the battery at will.) The lamps are generally operated in parallel, and in this system are sixty or sixty-five-volt lamps. When the battery, consisting of thirty-two cells, is freshly charged, its voltage is approximately two volts per cell, giving a total voltage of sixty-four volts across the lamp mains. As the battery is discharged this voltage will decrease, but should never be allowed to fall below sixty volts. On the other hand, it must never be allowed to exceed sixty-four volts.

If the train is brought to a speed such that the generator develops, say, seventy-two volts, sufficient to force about half the charging current through the battery, and the automatic generator switch be closed, the voltage at the terminals of the battery, and hence that impressed on the lamps, is seventy-two volts. This is an increase of twelve and one-half per cent in lamp voltage, an obviously excessive variation, while at eighty volts, which is necessary to force the full charging current through the battery, the variation in lamp voltage would be twenty-five per cent, which would probably be followed by destructive effects. In order that the voltage may remain constant at the lamps, irrespective of the rise of voltage at the battery terminals coincident with charging the same, it is necessary to resort to some form of artificial regulation.

In other words, a variable drop must be taken up in the lamp circuit, either by a variable resistance or rheostat, or by a variable counter-electromotive force, to compensate for the rise of voltage at the terminals of the battery. But as the current in the lamp circuit may vary, due to a change in the number of lamps, a rheostat must change its resistance, not only to compensate for the rise in electromotive force at the terminals of the battery, but also to meet the variation in the number of lamps in use. This requires a double variation of resistance, which, to be automatically performed, is very difficult. Hence a device having no resistance, but capable of developing a variable counter-electromotive force, is far preferable; and a low-resistance armature, revolving at constant speed in a field which varies as the rise in electromotive force at the terminals of the battery, is independent of the variation in the lamp current due to changes in the number of lamps, and constitutes such a device.

All the currents and electromotive forces developed in an axle-driven car-lighting system are variables, and are functions of the train speed. There is, however, one rectilinear relation that exists among these quantities that can be utilized to produce a constant lamp voltage. It is an observed fact that the current that may be forced through a storage battery is almost directly proportional to the electromotive force applied at its terminals, less the counter-electromotive force of the battery itself. In other words, the current forced through the battery (charging) is proportional to the increase in electromotive force at its terminals. This is true over the greater range of the battery's capacity. As the battery is charged, its counter-electromotive force rises slightly, and hence, when the battery is fully charged, the lamps will be brighter than if the battery were exhausted.

This relation between the charging current and the rise in voltage at the terminals of the battery is utilized in a manner extremely simple, theoretically perfect, and in practice so nearly so, that it requires the use of a good voltmeter to detect the changes in voltage on the lamps, no matter how many be in use or what the speed of the train may be.

THE "BUCKER."

A separate auxiliary and self-contained machine, which we call a "bucker," is bolted to the bottom of the car in any convenient place. This machine contains a revolving shaft on which are mounted two armature cores. One of these armatures, with its commutator and field, constitutes a plain shunt motor which takes its power from the generator mains and whose sole function is to rotate the shaft. It is obvious that this motor runs only when the generator is in operation. The other armature has two windings and two commutators, and revolves in a field excited by the current flowing through the battery. This double-wound armature, with its two commutators and field, constitutes the "bucker" proper. The motor simply drives it. The winding connected in the lamp circuit is called the "lamp bucker," and the winding connected in the field circuit of the generator the "field bucker." The field of the "bucker" is referred to as the series field.

The motor and "bucker" armatures are drum-wound for bipolar fields. They are built up of slotted annular punchings, and mounted, together with their commutators, on a sleeve which is fitted and keyed to the shaft. The construction is very similar to and possesses all the advantages of that employed in the generator armature previously described. There is no pulley or external mechanical connection to this machine.

The field is of the bipolar, ironclad type. Each armature core revolves between two salient pole-pieces, which are bolted into the casing, and consist of a pole-shoe and core. Upon each core is placed a heavily taped and painted coil. The pole-pieces are placed in a vertical line, so that one pole or coil for each armature core is in the upper, and one in the lower, part of the machine.

The brush-holders are mounted rigidly in the upper half of the machine. Their springs, fingers and cams are interchangeable with those of the generator. In taking off the bottom half of the casing, or in removing the armature, no wire connections need be disturbed, beyond disconnecting the two lower field leads, and the two leads connecting the fields.

The head castings, containing the armature shaft bearings, are secured to the casing by four bolts in each, thus permitting the lowering of the bottom half of the casing with or without the armature. The armature is shown entirely removed, together with the head castings and armature shaft bearings. The separate parts of this machine are light enough to be easily handled, no jacks or lifting devices being necessary. By referring to the cuts, it will be seen that hand-hole covers are provided over each brush-holder, thus affording, by their removal, easy access to all the internal parts.

OPERATION OF THE "BUCKER."

When no current flows through the battery, none flows through the series field, and hence no electromotive force is generated in the "bucker;" but when current flows through this series field electromotive forces are generated in the "bucker," and in almost exact proportion to the strength of the field. After the closing of the automatic generator switch, the motor runs at almost constant speed, its slight acceleration as the generator voltage rises from sixty-four to eighty volts, being an advantage, as it compensates for the drooping curve of magnetization in the series field.

No current will flow through the series field under the following conditions:

First—When the generator is inoperative, automatic generator switch open, and no lamps lighted; *e. g.*, car standing still in daytime.

Second—When the generator is operative, automatic generator switch closed, no lamps lighted and the generator voltage equal to the battery voltage; *e. g.*, running twenty miles per hour in daytime.

Third—When the generator is operative, automatic generator switch closed, no lamps lighted and batteries discharg-

ing, carrying all or a portion of the lamp load; *e. g.,* running twenty to twenty-five miles per hour at night, lamps lighted. Current would, in this case, flow backward through the series field, as the battery is discharging, were it not prevented from so doing.

Fourth—When the generator is operative, automatic generator switch closed, lamps lighted, and generator just carrying the lamp load, batteries neither charging nor discharging; *e. g.,* running twenty-five miles per hour at night, lamps lighted.

Under these conditions, no regulation of generator or lamps is necessary.

Only one condition obtains when regulation is necessary, and that is:

Fifth—When the generator speed and voltage have risen and the battery is being charged; *e. g.,* running above twenty-five miles per hour, day or night. Then the voltage at the lamps rises, and it must be kept constant, whether the lamps are lighted or not.

The voltage at the terminals of battery rises about in proportion to the current forced through them. The magnetism of the series field increases in proportion to this current. The electromotive forces of the "bucker" (its speed being nearly constant) increase in proportion to its field magnetism. Hence, the electromotive forces of the "bucker" increase in proportion to the rise of electromotive force at the battery terminals. If the winding connected in the lamp circuit be proportioned correctly, its electromotive force can be made equal at all times to the increase of electromotive force at the battery, and so if this winding be connected inversely in series with the lamps it will produce a counter-electromotive force in the lamp circuit always equal to the excess electromotive force necessary to impress on the batteries to charge them. The result will be a constant lamp voltage, independent of the number of lamps in use, or the speed of the train, since the latter now affects the charging current only.

REGULATION OF THE GENERATOR.

The other winding of the "bucker" is connected inversely in series with the field of the generator, and generates a counter-electromotive force which weakens the field of the latter to such a degree that the electromotive force of the generator is just sufficient at the maximum train speed to force the maximum predetermined current through the battery and series field. The regulation tends to maintain constant current through the battery and series field at a given train speed. The lamp load is carried by the generator precisely as in the case of a constant-potential machine and does not affect the charging current flowing through the battery.

Since the "bucker" receives or absorbs energy from the lamp circuit and the field circuit of the generator, such energy is transformed into mechanical power and tends to revolve the shaft and thus relieve the motor of that work. In fact, when the apparatus is fully loaded, the motor becomes a generator and puts back into the system about sixty per cent of the energy consumed by the "bucker" in effecting regulation.

Under (3) no regulation for holding down the lamp voltage or generator output is necessary, but since, under such conditions, the battery would discharge and current would flow from the battery through the lamps, "lamp bucker," and backward through the series field, the polarity of the "bucker" would be reversed, and the latter would become a booster and tend to raise the lamp voltage and increase the generator output by strengthening the field of same. This tendency of the "bucker" to "boost" when the battery discharges through the series field, while the generator switch is closed and the triple contact open, as already explained, is prevented by causing the current which flows from the generator through the motor to return through the series field in direction opposite to that of the battery current discharging through the lamps and series field. This motor current increases with the tendency of the "bucker" to "boost," which tendency is proportional to the lamp load at this time, for the more heavily the "bucker" (now a booster) is loaded the greater the motor current required to drive it. As these two currents can not flow through the same field at the same time in opposite directions, their resultant, which in this case is their difference, is the current which actually flows; and such resultant can, by proper design, be made approximately zero; or, at least, the tendency to "boost" can be practically eliminated.

AIR-OPERATED FIELD SWITCH.

In addition to the difficulties to be overcome to render the electrical operation of the system perfect, there is one other point which requires attention, although not absolutely vital. For the sake of simplicity, a self-excited generator is usually employed, although it is not uncommon to separately excite the field of the generator by means of current from the storage battery. If such current be used to excite said field, provision must be made to discontinue it after the car goes out of service; otherwise, a useless discharge of the battery will take place. It is desirable to provide some form of separate excitation, as the generator may fail to excite or "pick up" at the proper speed through loss of residual magnetism, imperfect contact of brushes, etc.

In this system, the generator remains connected as a self-exciting machine, and eventually furnishes the strong current in its field required to produce sixty-four volts at the low speed of twenty miles per hour. Separate excitation for the field of the generator, and also for the field of the motor which drives the "bucker," thus enabling the motor to start readily, is supplied by means of current from the storage battery, which current is limited to a small value by the field resistance. The circuit from the storage battery through the field resistance is controlled by an automatic device called the air switch. This consists of a cylinder, to the lower end of which a branch from the signal pipe of the car is connected. An ordinary gas-cock, included in this branch pipe, serves to cut off the supply of air, so that the cylinder may be opened or disconnected without venting the signal line. Within the cylinder is a cup-shaped piston, to which a rod is attached. The latter extends through the cylinder head and carries an insulated contact disc. The piston is held in its normal position by means of a helical spring surrounding the piston rod, and engaging with the inside of the cup-shaped piston and the under side of the cylinder head. When the piston is forced upward by air pressure, the rim of the cup is pressed against the gasket, which packs the cylinder head, thus sealing the cylinder and preventing escape of air. This construction permits the use of a loose-fitting piston, which ensures freedom from possible sticking. At the same time the contact disc on the piston-rod establishes connection between the two spring contacts mounted upon and insulated from the cylinder head, and which are secured by the same bolts that hold the latter in place. The heads of these bolts form binding-posts for the reception of the circuit wires. A bonnet or hood protects the contact parts.

When the locomotive is coupled to the train and the hose couplings are connected, pressure is at once applied to the air-switch and the circuit is closed. When the locomotive is uncoupled, the pressure in the signal pipe rapidly falls, opening the air-switch immediately, or within a few minutes. Reduction of pressure, caused by giving signals, does not open the switch, and even if it did, no harm would result, as the switch may be opened with impunity as soon as the generator has developed a stable voltage of about fifteen volts. When the automatic generator switch closes, it short-circuits the air-switch, in addition to its other functions. After the disconnection of the locomotive, the conductors' valve may be used to open all the switches on a train simultaneously, in case the pressure in the signal pipe is retained. The leaks in the hose couplings are sufficient to cause a rapid falling in pressure and a quick opening of the air-switch.

INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—IX.

Notes on Progress in Europe and America.

BY JOHN B. C. KERSHAW.

Tin-Scrap.

The use of the electric current for stripping the tin from the waste tin-scrap found in all large cities, and from the cuttings produced in factories where tin sheet is used, has been the subject of many patents.

Theoretically considered, this use of the electric current has everything in its favor. The raw material of the process is a waste product, and, therefore, theoretically considered, should cost nothing; the amount of electrical energy required to separate the tin from the iron is small; the separation can be made complete, and, finally, the value of the recovered product is high. Therefore the industry should flourish in every country, and pay huge profits to those interested in it. But this application of electricity has not developed and extended as inventors and capitalists interested in it had hoped. The hindrance has not been due to any difficulty in carrying out the process. Tin-cuttings or tin-scrap, suspended in a basket in an electrolyte of caustic soda, and used in this position as anode, can easily be stripped of the tin by the action of the electric current; eighty-eight per cent of this tin can be deposited in the spongy state, and obtained as metallic tin by a later smelting operation. The difficulty that has arisen is due to the small amount of tin contained in average tin-scrap. Dr. Mennicke, in a series of articles which has appeared in the *Zeits. f. Elektrochemie* during May and June, 1902, has stated that the percentage of tin is only 3.5 per cent. Therefore a very large amount of scrap and cuttings must be collected, in order to feed the recovery works with a supply sufficient for regular operation on a large scale. It is the cost of collecting and transporting this scrap to the works where it is to be treated that forms the chief difficulty in operating the electrolytic tin recovery process. As might be expected, Germany is the country in which most progress has been made, and, according to Dr. Mennicke, 30,000 tons of tin-scrap are now worked up annually, in seven factories operating the electrolytic process. Although the use of other electrolytes has been proposed and patented, sodium hydrate is stated to yield the best results. In Austria, one tin recovery works is stated to be in operation; and England possesses one small experimental plant at Manchester. Germany at present is drawing supplies of scrap for the seven works named above, from England, France and Switzerland; the home supply proving insufficient to meet the requirements of the works. This state of things is unlikely to continue, and it is evident that a well-situated electrolytic recovery works, with a good organization for the collection and transport of the scrap and cuttings, is demanded, and will some day be found in operation in each of the countries named, and also in the United States.

Arsenical Ores.

Westman has patented an improved form of electric furnace for dealing with ores containing large amounts of arsenic, and it is claimed for the Westman furnace and process that not only is the danger from the escape of poisonous fumes lessened, but that the gold and silver present in the ore in small amounts are obtained in the residue in a form that leads to a profitable recovery. The furnace is closed to exclude the air, and the heating occurs by means of an alternating current and cast-iron electrodes cooled by water. The arsenical ore is charged on to the hearth of the furnace, which is covered with a molten layer of lead, and any gold or silver present is dissolved out and retained in this bath of molten lead. The volatilized arsenic arising from the furnace is conducted away to a series of condensing chambers provided with partition walls and bottom doors, and it is condensed in these in the form of grey particles of the metal. The Arsenical Ore Reduction Company, of Newark, N. J., has been formed to work this process in America, and it was stated in October, 1901, that operations were about to be commenced with rich mispickel ore (arsenical pyrites) from Ontario. When operating with this ore the sulphur combines with the iron, and only the arsenic volatilizes. In the preliminary trials with the Westman process it was stated that 1.270 kilowatt-hours were required for smelting one ton of the ore, but this figure would appear to be a misprint for 1,270 kilowatt-hours. The development of the Westman process will be handicapped by the fact that the arsenic is obtained as metal, and that a further roasting operation will be necessary to obtain it, in the form of the white arsenic (As_2O_3) in which it is chiefly used in the arts and industries. Unless great care is exercised in choice of ores the product is also likely to be much contaminated with other volatile elements, of which sulphur, antimony, cadmium and zinc are the most common examples. However, in spite of these hindrances the Westman process may develop.

The Calcium Carbide Industry in Europe.

The calcium carbide industry in Europe is only slowly recovering from the effects of the over-expansion and over-capitalization which marked the years of "boom" 1897-1900, and it is yet premature to assert that the industry has attained a position of stability both as regards production and finance. As pointed out in note chapter III, upon the electric furnace methods for production of iron and steel, the present activity in this direction is largely due to the number of shutdown carbide plants in France and Switzerland, and to the urgent necessity for finding some profitable use for the many hundreds of horse-power now running to waste in these power installations. One of the latest results of the financial crisis through which the industry has passed is the liquidation of the Acetylen-gas Aktien Gesellschaft, of Budapest and Vienna. This company was formed in 1897, and owned the calcium carbide factory at Meran in the Austrian Tyrol, where remarkably cheap water power was available for the manufacture. When erected, this works was considered a model calcium carbide factory, but in spite of its numerous advantages it has been unable to survive the period of depression which has overtaken the carbide industry. Selling bureaus or "cartels" for the regulation of output and price now exist in France, Sweden, Germany, Switzerland and Austria-Hungary, and in France the carbide manufacture is controlled by the company owning the Bullier patents, which have been upheld in the patent case recently fought in the French courts.

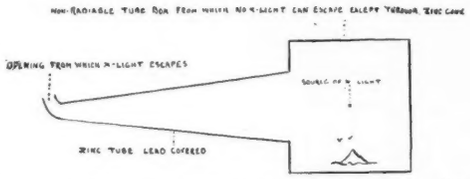
In Germany and England the Bullier and Wilson patents have not survived the ordeal of the law courts, and in these countries the manufacture of calcium carbide is now an open one. The financial prospects are, however, not sufficiently bright to attract outside firms into the industry, and in the United Kingdom the British Aluminium Company is reported to be thinking of shutting down the carbide plant at Foyers unless better terms can be obtained from the Acetylene Illuminating Company which acts as selling agent. The latest price list issued by this company quotes $4.32 per hundredweight for Foyers carbide. The selling agent must therefore be making large profits if the price paid to the aluminum company for manufacturing the carbide is too small to admit of a profit, for it is now generally recognized that carbide can be produced in a well-equipped factory at a cost of between $50 and $70 per ton.

NOTES ON X-LIGHT.

BY WILLIAM ROLLINS.

NOTE CXLIV—ON THE IMPORTANCE OF REFLECTED X-LIGHT IN THERAPEUTICS.

Rœntgen (Wurzburg Physicalisch Institut der University, December, 1895) reported that some metals, particularly zinc, reflected X-light in an angular manner. Tesla also published a table showing the proportions of transmitted and reflected light. He confirmed Rœntgen's statement in regard to zinc and made a cone of this metal to concentrate the light. I took advantage of



ZINC CONE FOR TREATING DISEASES OF THE MOUTH, NOTE CXLIV.

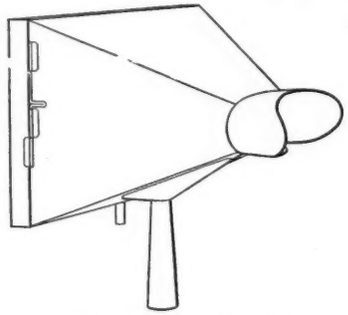


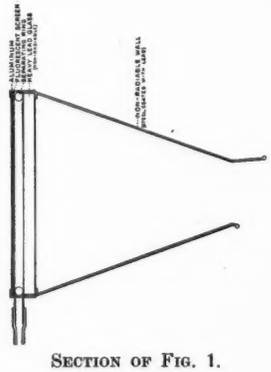
FIG. 1.—CRYPTOSCOPE.

these observations to make zinc cones in which the light went around a corner for treating diseases of the mouth. One of these is shown in the figure. To prevent any X-light from escaping from the tube, except through the open end, the outer wall was made of lead. This construction allowed the tubes to be sterilized by heat. In use the large end of the tube was attached to the tube box that no X-light could escape into the room except what went out through the small end of the cone. There should be several ends of different diameters. It is of course obvious that the plan is useful for treating other parts of the body.

NOTE CXLV—ON THE DEVELOPMENT OF THE CRYPTOSCOPE, USUALLY CALLED THE FLUOROSCOPE.

Salvioni (Medico Surgical Academy of Perugia, February 8, 1896) placed the fluorescent screen, used by Rœntgen, at one end of a tube, which had an opening for the eyes at the other. He called the instrument a cryptoscope. Professor W. F. Magie, *American Journal of Medical Science,* February 7, 1896; E. P. Thompson, daily papers, February 13, 1896, did the same thing in America, where the instrument was called a sciascope. Edison used tungstate of calcium for the fluorescent salt and called the form of instrument which he designed and which is now in general used, a fluoroscope. If we follow the usual custom of science we should use the first name, which, therefore, in future, I shall employ in these notes.

Rollins (ELECTRICAL REVIEW, February 8, 1899; *Boston Medical and Surgical Journal,* January 31, 1901) added a sound chamber to the cryptoscope, thus enabling the sounds of the heart and lungs to be heard while their shadows were being examined on the fluorescent screen, calling the instrument a Seehear. Having found that animals could be made blind by X-light he advised (ELECTRICAL REVIEW, June 14, 1902) interposing a screen of heavy lead glass between the fluorescent screen and the physician's eyes, stating that most of the X-light passed unchanged through the screen of fluorescent salt. He also insisted upon the necessity of making the cryptoscope of non-radiable material as a means of preventing diffused light from entering. In the present paper attention is called to some details not particularly dwelt upon in the papers mentioned.



SECTION OF FIG. 1.

First it is important to construct the cryptoscope of such material that it may be easily sterilized by heat, as it is now constantly used about patients having contagious diseases. The cloth-covered pasteboard or wooden fluoroscopes in use with their fuzzy lips can not be sterilized by heat as they would fall to pieces. Therefore, for this reason also, the cryptoscope should be made of metal like the one shown in the *Boston Medical and Surgical Journal* for January 31, 1901. The construction of such an instrument, designed for Dr. Williams, is shown with

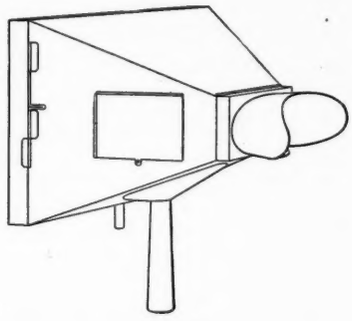
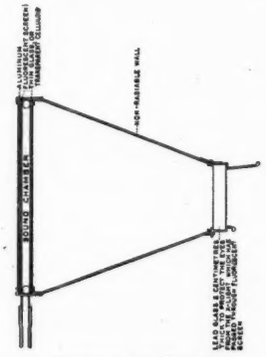


FIG. 2.

some detail in the figures accompanying this note. Fig. 1 shows the instrument in one of its earlier forms where it followed the general form introduced by Edison, but had a sheet of heavy glass over the screen, and the walls were made of non-radiable material. On account of the



SECTION OF FIG. 2.

weight of the large plate of glass, more than four pounds, a different construction was adopted, the glass plate being reduced in size and placed at the eye end, as in Fig. 2 and its section. To convert the instrument into a Seehear, it is only necessary to add the stethoscope tube as in Fig. 3.

To limit the area of the sound chamber, limiting forms are introduced which are clearly shown in Fig. 4 and its section. All stethoscope tubes have been made of soft rubber to get flexibility. Heat has an injurious effect upon this, therefore to enable the whole instrument to be sterilized I invented the plan shown in figure, the tubes being made of metal, flexibility being obtained by forming the wire into closed spirals.

Fig. 5 shows the cryptoscope used as an X-light beam finder. The door shown on

the sides of the cryptoscope is removed, as well as the eye piece, and their positions reversed, the eye piece being placed on the side, the door on the eye end. The door is made of two layers of metal, the inner of this aluminum, the outer, which can be turned back on a hinge, of non-radiable material. For use the outer layer is turned back when it is at the eye-piece end to allow the beam of X-light escaping from the tube box through the opening of the diaphragm to pass through the aluminum to the fluorescent ring at the other end of the cryptoscope.

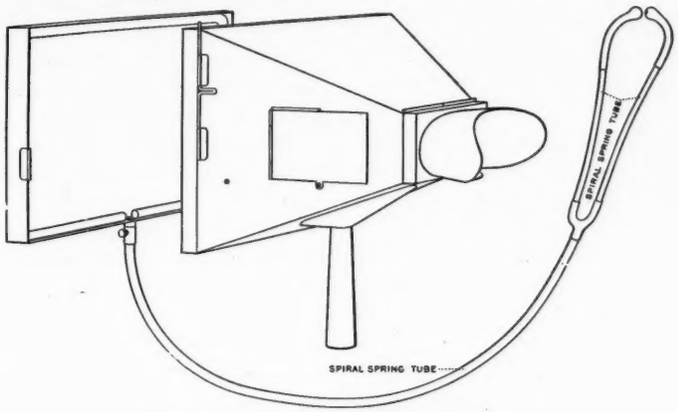


FIG. 3.—SEEHEAR, WITH FRONT REMOVED.

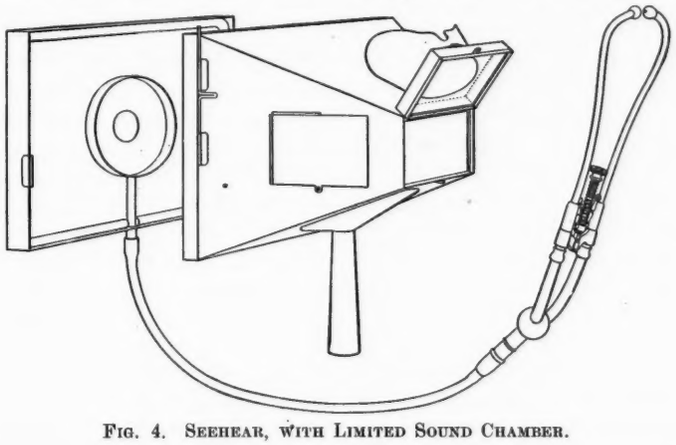
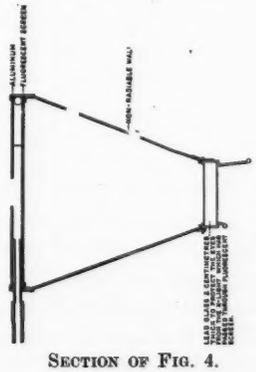


FIG. 4. SEEHEAR, WITH LIMITED SOUND CHAMBER.

In treating an area of diseased skin we desire, as far as practical, to know exactly where the beam of X-light strikes the patient and to have some simple means of limiting the area of the beam to the diseased area. The cryptoscope, arranged as shown, enables this to be quickly done. The aluminum sheet closing the large end of the cryptoscope has a hole in it to admit daylight reflected from the area of the skin to be treated. Around this hole is a ring of fluorescent material. As the physician sits by the side of the patient he brings the eye end of the cryptoscope against the diaphragm opening of the tube box, looks into the cryptoscope through the eye piece now attached to the side and sees in the mirror on the opposite side an image of the piece of skin to be treated surrounded by a fluorescent halo caused by the beam of X-light where it strikes the fluorescent salt. Then by moving the milled head of the adjustable diaphragm the area of the beam of X-light, where it strikes the fluorescent screen, is diminished until it only covers a little more of the skin than is to be treated. The cryptoscope may then be removed



SECTION OF FIG. 4.

with the assurance that no more X-light is falling on the patient than is required. Instead of using the cryptoscope in this way the room can be made dark and a different form of instrument employed. It consists of a metal frame with a central hole, around which is a fluorescent screen. The metal frame is held so that the hole is central with the area of skin to be treated, and the beam of light reduced as before until it a little more than covers the proper area.

NOTE CXLVI—ON THE FORM OF CURRENT FOR EXCITING X-LIGHT TUBES.

In former notes it was shown that—

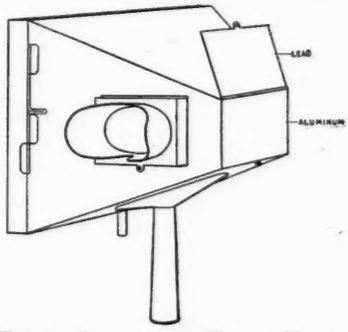
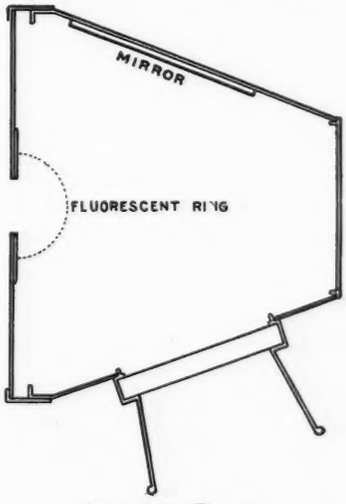


FIG. 5.—CRYPTOSCOPE USED AS FINDER.

first, an alternating-current generator uses up an X-light tube more rapidly than one giving the so-called unidirectional current; second, to get the maximum amount of X-light for visual work with the fluorescent screen, the current



SECTION OF FIG. 5.

should be sent in enormous surges, the intervals between being as long as is consistent with a light apparently continuous to the eye; third, to get these large surges we can use a condenser in the secondary circuit of the induction coil.

But Henry showed that the discharge of a condenser was a series of oscillations. Therefore when such discharges are used to excite an X-light tube some means of changing the character of the discharge is needed. I refer to this matter again because coils are now being made in which my methods of construction are, to a certain extent, being embodied, yet

the makers, not understanding the proper conditions required for exciting an X-light tube, are placing condensers in the secondary without pointing out the importance of changing the form of the current produced when they are used. The best means to employ I am not in a position to state, but a water resistance or a properly constructed vacuum tube are both available at the present time.

NOTE CXLVII—X-LIGHT AS A MEANS OF IDENTIFYING CRIMINALS.

Several systems of identifying criminals are in use based upon measurements. I have proposed another based upon X-light photographs of the criminal's bones, those of the hands and feet for example. Now that manufacturers are selling X-light apparatus for $200 the system is worth attention, as it requires little time to carry it out. With the present systems it is customary to make a photograph of the criminal's face, therefore the carrying the photographic process to his bones would be easy, for the photographer could be taught to do this in a month. The time required would be short, as twenty seconds is sufficient for the photographing of the extremeties by X-light with ordinary apparatus. I have examined a large number of X-light photographs of the hands and feet and feel sure that the chance of finding two alike would be very small. When we consider that an X-light photograph shows not only the shape of the bones but their internal structure, the chances are almost infinite against two being alike. When this method is used my central axis marker, position and distance finder must be used in order to be sure that the source of X-light bears a fixed relation to the plate. I have examined pictures of the same bones taken at intervals of six years and find that the differences are too slight to prevent identification in that time. It is not to be expected that two photographs taken at long periods apart will be identical, as some diseases are known to change certain characteristics of the bones, but so they do of all the other parts of the body.

Proceedings of the Fourth Annual Supervisors' Highway Convention.

Bulletin No. 5, relating to the improvement of public highways, contains the proceedings of the fourth annual Supervisors' Highway Convention. The report of the standing committee is given in full, with the discussion, and many illustrations show the progress of the work in various sections of the state and country. The bulletin includes also Mr. Frank D. Lyon's paper on "Economic Measures by Counties for the Improvement of Highways," and discussions on "The Money System," and "A Compulsory Wide-Tire Law."

MUNICIPAL ELECTRIC LIGHTING OPPOSED.[1]

BY JAMES BLAKE CAHOON.

When discussing the question of municipal ownership in the United States I shall not take up the experience of countries other than our own, for the customs of foreign countries are so radically different from our own that we can not base what we should do upon what has been, or is being, done in other countries. We must be a law unto ourselves and look at the matter in the full light of our political system, and take up the question of conserving the interests of the community in the broadest-minded spirit.

MUNICIPALIZATION THE WORK OF POLITICIANS.

The great majority of cities in this country have, and still continue to, let out the contracts for this work to the private corporation, and on the whole this has worked satisfactorily, though instances have arisen where there has been occasion for dissatisfaction with the service or with the price asked, so that the municipality has, in a measure, been forced by local sentiment and conditions to enter upon this work itself. But such instances have been rare. Where the city has undertaken the manufacture and distribution of electricity, it has usually done so at the instigation of interested parties who have started the cry that this service, inasmuch as it serves the whole people, should be done, therefore, by the whole people. The American people are peculiarly susceptible to such an appeal as this. They are an enthusiastic people, and once their enthusiasm is aroused in favor of a project they are easily led into doing things which they would not be guilty of doing in their sober moments.

I have been through this experience several times, have seen political leaders arouse this sentiment in the people and guide them along the path tending to municipal ownership and operation and have found the current in its favor so strong that it seemed absolute folly to attempt to check or resist it. The only way of heading off such a movement was by fighting it like a prairie fire, *i. e.*, by starting an opposing flame, burning out to meet the oncoming rush of the greater flame. Thus a different sentiment was started and carefully worked up. The better element of the city was taken into our confidence; they were shown the inside workings of the electric light company, what it costs to manufacture and distribute the current, what factors were omitted in the estimates of those favoring municipal ownership that had to be reckoned with in a private company. Then the experience of other cities was placed before them and the cost of operation and furnishing light, as given out by such cities, was gone into and analyzed, and the things that were omitted in making up those costs were added. Afterward the question, who will reap the benefits of a change from private to public ownership, always pertinent in our form of government, was very thoroughly discussed, and it ended up with the pretty direct proof that the politicians, who had started the agitation in favor of municipal ownership, would be the men to benefit by the change. Yet to-day we find that after many disastrous experiences, cities are still threshing over the old ground of whether it will pay them to build their own plant and light their own streets.

CHICAGO'S PLANT EXAMINED.

Detroit and Chicago have done this on a more extensive scale than any other cities in the country, and if one were to go to the commissioners having these plants in charge, he would get a statement showing that it is much cheaper for cities to operate their own plant than to enter into a contract with a private lighting company. Let us examine the facts.

In 1898 the city of Boston entered into a contract with the Boston Electric Light Company for illuminating its streets with lamps which should consume an average of 500 watts of electrical energy, with a minimum of not less than 480 watts, such lamps to be of the enclosed type, or, in other words, the modern up-to-date lamps for street service. This contract was only entered into after one of the most careful investigations that has ever been made on this subject in this country, or in fact, in any country. This investigation was made by Nathan Matthews, Jr., whose fairness and ability no one would question. At the time he made his report the cost given to him for one light per annum, for the municipal plant of the city of Chicago, was $87.38, to which, he stated, should be added for omission on account of salaries, $1.62 per lamp, making the cash outlay per lamp per annum $89. Starting with this cost, he added the following: Rent value of offices used by the lighting department, $1; taxes relinquished, $1.64; insurance on eighty per cent of the value of the plant and at the rate of one per cent, $1.62; liability in-

[1] Paper read at the recent National convention on Municipal Ownership and Public Franchises, held in New York city.

surance, $3.51; depreciation, $36.60, being an average of six and one-half per cent on the plant and apparatus, lines and underground work, exclusive of the cost of land. Adding to this interest on the investment at four per cent, or $21.84, he obtained a total annual cost, figured on a commercial basis of $155.21 per light per annum.

Now in regard to these items: If the city does not, on account of its owning the plant, tax itself, it is going to lose just that much of revenue, which it would receive were it a private plant doing the work and being taxed for it. Consequently, as it loses this revenue, which has to be made up elsewhere by increased taxes, it is only fair to add this to the cash cost of electric lighting. In regard to insurance, there is no good reason why the city should not include this charge as a private company would, and it should include liability insurance for the same reason.

ALLOWANCE FOR DEPRECIATION.

As to depreciation, the municipal plant does not differ from the private plant, and it has been found by actual experience, extending over some twenty years, that we must take into account depreciation of the apparatus, buildings, lines, lamps and everything connected with the manufacture and distribution of electricity, with the exception of the land. It has been argued that modern apparatus is so much better than that formerly put out, that it is not now necessary to charge as much for depreciation as would have been the case ten years ago. But it is not the simple wearing out of the apparatus that must be taken into account. We are progressing constantly; changes are being made even to-day in electrical apparatus, and what was all right ten years ago, five years ago, two years ago, must be discarded and thrown into the junk heap because new inventions bring about economies which render it imperative for us to throw away the old apparatus, though it may be in good operative condition. It is useless to say that electrical apparatus has reached its highest point of development or even that electrical apparatus will be used ten years from now. We simply know that we have had to throw away apparatus and probably will have to do so in the future. When electricity came in, cities practically did away with gas as an illuminant; their lamp-posts became worthless and went into the scrap heap; so in like manner the next ten years may bring something to the front that will cause us to throw away all our electrical apparatus and take up a new method of lighting. For these reasons we must consider depreciation.

Haskins & Sells made a report on this plant to the Reform Club, which appeared in *Municipal Affairs* for March, 1902, and has been widely quoted, inasmuch as it is the most complete report of costs of this plant that has ever been obtained. They show in their report that if no provision were made for a sinking fund, there would still be a loss in the years 1887—1900, inclusive, of $49,423.11 over what the city would have paid if it had taken power from the private company at the rate which the private company charged for a small number of lamps. This is hardly a fair comparison, for the reason that if the private company had been able to operate all the lamps of the city it would have made a lower price per lamp than it has for operating only a small number, and this city could have specified the modern enclosed type of lamp in its later contract, with consequent reduction of price, incidental to the economy of this type of lamp.

By referring to Document 111, of 1898, message of Mayor Quincy, of Boston, giving the report of Mr. Matthews, it will be found that his estimates of cost per lamp are based on the capacity of the plant January 1, 1898, the capacity of the plant at that time being 1,438 lamps. In the report of Haskins & Sells, Exhibit D, under 1897, the capital cost per lamp is given as $280.06 and the capacity is given as 3,850 lamps; and partly to this discrepancy is due the lower cost reported by Haskins & Sells. By referring to our former figures of $155.21 we find a discrepancy in the estimate of the two parties of $17.10, due partly to the fact that Mr. Matthews took the cash cost as given him by the city authorities as a starting point. The difference between the cost as made by Haskins & Sells and that reported by the city authorities being $8.57, the balance being largely made up in the amount allowed for insurance and depreciation, Haskins & Sells evidently omitting liability insurance and allowing but five per cent for depreciation.

It may be well to give the rate of depreciation which Mr. Matthews allows on the different parts of the plant, so that those familiar with the subject of depreciation may judge whether Mr. Matthews was in error in his allowance or not. On buildings, 4 per cent; steam plant, 7½ per cent; electric plant, 10 per cent; poles, hoods and lamps, 10 per cent; conduits and cables, 5 per cent; or an average of about 6½ per cent on the whole, exclusive of the land. There are two items in this that I should criticise adversely: one is the amount of depreciation on buildings, and the other, depreciation on conduits and cables. I think two per cent is ample to allow for buildings and three and one-half per cent for conduits and cables, though this latter item ought to be split up. The depreciation on the conduits, if properly laid, should be very small, not over two per cent, but five per cent depreciation on cables would not be too much. Making these changes would bring the average depreciation to 5.7 per cent and Mr. Matthews's cost down to $151.57 on a purely commercial basis, *i. e.*, considering that the Chicago plant should pay the full amount of insurance, both fire and liability, which is customary for a private plant to pay.

CHICAGO EXPERIMENT UNSUCCESSFUL.

Under table III of Haskins & Sells's report it will be seen that there is a considerable decrease in the cost of electric lighting as estimated by them, declining from $138.11, the cost for the year ending December 31, 1897, to $97.86, the cost for the year ending December 31, 1899, and increasing to $99.88 for the year ending December 31, 1900, giving the cost per lamp-hour as 0.039 for the year ending December 31, 1897, and 0.0257 for the year ending December 31, 1900. The average number of lamp-hours for the last period was 3,910.

	Price of Coal Average.	C. P. Per Hour for One Cent Average.	Price of Gas Per M. Average.	Average Cost Per Lamp-Hour.
Alabama	$1.82	759	$1.72	.0229
Arizona	8.00	250	2.00	.0489
Arkansas	2.87	509	2.00	.0423
California	8.29	578	2.24	.0370
Colorado	3.37	894	....	.0279
Connecticut	4.08	429	1.48	.0344
Delaware	3.25	1,282	....	.0162
District of Columbia	....	1,111	....	.0120
Florida	2.45	680	2.00	.0268
Georgia	2.89	689	1.63	.0261
Idaho	....	883	....	.0292
Illinois	1.57	705	1.49	.0296
Indiana	2.01	682	1.38	.0270
Iowa	1.66	679	1.58	.0284
Kansas	2.48	565	0.96	.0355
Kentucky	1.92	799	1.54	.0272
Louisiana	3.37	661	2.50	.0245
Maine	4.85	782	1.95	.0277
Maryland	2.00	849	2.00	.0352
Massachusetts	4.58	449	1.58	.0363
Michigan	2.77	633	1.37	.0315
Minnesota	3.91	699	1.32	.0282
Mississippi	2.41	610	2.22	.0323
Missouri	2.32	594	1.76	.0331
Montana	7.50	734	2.00	.0281
Nebraska	2.93	581	2.07	.0373
New Hampshire	5.46	531	1.66	.0341
New Jersey	3.34	689	1.35	.0244
New Mexico	3.00	450	2.25	.0444
New York	3.07	735	1.68	.0264
North Carolina	3.40	580	1.80	.0280
North Dakota	5.50	1,219	2.00	.0164
Ohio	1.78	829	0.92	.0249
Oklahoma	4.00	688	....	.0625
Oregon	....	915	....	.0198
Pennsylvania	2.18	902	1.27	.0221
Rhode Island	4.16	289	1.45	.0429
South Carolina	3.34	884	2.25	.0228
South Dakota	6.00	242	....	.0826
Tennessee	2.01	916	1.18	.0208
Texas	4.12	609	1.97	.0319
Utah	3.00	1,062	1.65	.0189
Vermont	5.82	144	1.98	.0308
Virginia	3.36	1,001	1.19	.0189
Washington	3.83	985	1.93	.0210
West Virginia	1.45	694	0.50	.0268
Wisconsin	3.41	691	1.58	.0281
Wyoming	....	597	3.00	.0834
Average for U. S.	3.43	655	1.72	.0238

I have had prepared a table giving the average cost per lamp-hour in the different states and candle-power-hour for one cent, the price of coal and the price of gas. The cost per lamp-hour includes both 2,000 and 1,200-candle-power arc lamps, and to this extent is not comparable with the cost per lamp-hour in Chicago, for the reason that 1,200-candle-power lamps are included, while Chicago burns only 2,000-candle-power lamps. At the bottom of the table is given an average for the whole country. The data are obtained from approximately 800 plants in the United States. I put it this way simply to show the fallacy of using the lamp-hour basis as a method of comparison between cities. If we refer to the candle-power-hours furnished for one cent, this gives us a more accurate method of comparison, but even this should not be used by cities to determine the relative cost, but the method followed by Mr. Matthews should be used; *i. e.*, taking into consideration all the local conditions, the candle-power furnished for one cent might be used simply as a preliminary comparison, as it will show whether it is worth while to go further into details. For instance, take the state of Illinois. We find that the private plants throughout the state furnished 705 candle-power for one cent and these plants are divided into various small plants in the different cities in the state, no one of which is supplying any great number of lamps, the plants not being large enough to obtain the economies that may be practised by a single company furnishing the number of lamps demanded by Chicago. The number of candle-power-hours for one cent furnished by the Chicago plant for the year ending December 31, 1900, was 782, whereas the average candle-power-hours furnished for one cent in Delaware is 1,232; District of Columbia, 1,111; North Dakota, 1,219; Utah, 1,062; Virginia, 1,001; Pennsylvania, 902; Washington, 985; Oregon, 915; Tennessee, 916, etc.; while, of course, where the plants are small and coal is high, as in some states, the candle-power-hour furnished for one cent runs low.

The cost of fuel must be taken into account, and for practical purposes of comparison we would get a better result were we to divide the candle-power-hours by the cost of coal per ton and compare the results thus obtained for determining whether it would be advisable from a financial standpoint for a city to further consider the question of undertaking to light its own streets. The cost of coal in Chicago is given as $2.25; dividing 782 by this gives 347. Comparing this with the average throughout the state, cost of coal as $1.57 and average candle-power-hours as 705, we get 440. The comparison should be made in the following manner: The results obtained from the divisions should be inversely proportional to the prices of coal; or 1.57 : 225 :: 3.47 : 500. But dividing 705, the average candle-power for one hour throughout the state by 1.57 gives only 440, whereas, in order to do as well as the city of Chicago, other things being equal, the result should be 500. In other words, the big plant in Chicago is only doing about twelve per cent better than the average of the small plants throughout the state, when we might fairly look for at least thirty per cent. In other words, if a big plant with an approximate capacity of 5,000 lamps can not show a better economy than twelve per cent over the average country plant in the same state, we may fairly assert that this plant has failed to effect any saving to the city.

LOWER EFFICIENCY OF MUNICIPAL PLANT.

In a paper read before the League of American Municipalities, at the Syracuse meeting, in 1899, I laid down as a fundamental proposition that a municipal plant could not be operated as cheaply as a private plant, however conscientiously those in charge might try, for the simple reason that the employés in the municipal plant lack the incentives to economy which are ever present in the private plant. Later experience has only served to confirm my views. Even adopting a system of appointment on merit, and retain a man so long as he does his work well in the ordinary interpretation of the term, *i. e.*, so long as it will pass muster. His job is secure whether he tries to save the last cent for the city or whether he does not try. This is not true in the private plant. In the latter, if a man is not economical to the last degree, he very soon finds himself deposed and out of a job. A private company will not tolerate simply passable work, for the reason that they can always get men who will do good work.

Further, under ordinary conditions, no municipality ever has operated or can operate a plant so that the expenses of operation will not be at least ten per cent greater than the same plant operated by private enterprise. If any one will study the report of the State Board of Gas and Electric Light Commissioners of Massachusetts, giving the costs of municipally operated plants as well as private plants in that state, I think my statement will be verified.

MUNICIPALIZATION HINDERS PROGRESS.

But let us assume that the municipal plant can furnish lights as cheaply as the private plant or even a little cheaper, and look at a totally different phase of the matter of municipal ownership and operation. The United States leads the world to-day in the manufacturing field and it does so by reason of the fact that the people have encouraged in every way possible the development and perfection of machines and processes, whereby greater economy in and the maximum of production of manufactured articles is obtained. Looking at electricity in the sense of a product, it may strictly be classified as a manufactured article; and as such, every encouragement should be extended to those who have entered upon its manufacture and distribution to cheapen their product. This was done at first, with the result that the price of this product has been more than cut in two since its first advent in a commercial way twenty-five years ago.

Electric light companies found this to be the situation: "We have placed a price upon our product which is only a reasonable return upon the investment, if we get a certain amount of business; but our losses are so great between the coal pile and the consumer that we are only getting pay for one-third to one-half of the whole product." As soon as this was realized, every central station man in the country became interested in how he could deliver a much greater portion of his product. As one problem after another was solved, he found he could cut down the price to the consumer, and by making such a cut sell enough of his product to offset the reduction in price. To-day, it has become an accepted axiom among central station men that the profits of electric lighting enterprises are enhanced by keeping up the economy of the plant to the highest degree and selling the product at as low a figure as possible to get a fair return on the investment.

A striking example of this occurred in my own practice as consulting engineer when I was called upon to reorganize an electric light plant that was not paying. Upon investigation I found that the plant had been maintaining such high prices for its product that people felt that they could not afford to use electricity for lighting and power purposes, and that the plant had not been kept up to date. About the first move was to cut the rates for motor service fifty per cent and to

adopt a sliding scale proportionate to the current consumed during the month, with a result that people who had never considered the use of electric motors very quickly adopted them. The same process was followed in regard to electric lighting for commercial purposes, and within sixty days the number of lamps connected had increased twenty-five per cent, with prospect of being doubled before the season was out, and I look for a quadrupling of the number before the end of next season. The general result of the new policy is that the plant was on a paying basis and will be able to pay dividends by the end of another year.

If electric light plants are municipalized we will take away the incentive to progress toward a cheaper method of production and a cheapening of price accordingly; for it is a well-known fact that where municipalities have started into any such enterprise, so far as they were concerned, progress has ceased. Electricity is by no means fully developed, even at the present time, great as have been the improvements over the crude apparatus of several years ago, and the only way in which further improvements can be made is by the private companies forcing the manufacturers to improve apparatus. Therefore, the people at large for their own interests should do everything they can to encourage electric light companies in their efforts to secure better apparatus with the resulting economy and lower prices to the consumer. If we remove the pressure upon the manufacturing companies through municipalizing the plants, they will cease their efforts toward improving apparatus that produces greater efficiency. They might continue to improve apparatus to cheapen manufacturing cost so that they could make larger profits, but that is not what is wanted. The electric lighting man more than any other wants the best apparatus that can be made, and by best I mean apparatus requiring least repairs and showing greatest economy.

LIGHTING COMPANIES SHOULD BE FAVORED.

I have often wondered why it is that electric lighting companies have been given such shabby treatment by cities. About every city of any size has its board of trade, and its members do everything they can, even to the extent of giving free sites or buildings or both, to get some little manufacturing plant to come to that city; and yet, if an electric light plant is projected, it never receives the slightest assistance, but is held up in all sorts of ways, presumbly because electric lighting companies are usually incorporated instead of being carried on by single individuals or by partnership arrangement. Yet it has justly been classed as one of the public utilities; its business is to serve the people generally, and in order to convey its product to the consumer it must make use of the public streets, necessitating the granting of a franchise and a permit, as it were, to do business.

In a measure I think electric lighting companies themselves are largely to be blamed for this condition of affairs—due to giving an erroneous impression at the outset. When this business was first started people had an idea that it was a veritable gold mine irrespective of how it was managed, and those who went into it were inflated with their own importance for a time, but that time lasted long enough to make it up-hill work for all those who succeeded them. No one who knows anything of this business thinks to-day that anything can be made out of it except by practising the most rigid economy, working early and late and everlastingly hustling for business. To-day the old electric light companies are heavily capitalized, not from injecting water into their securities, but from the fact that they have paid the usual penalty for entering a new field. They paid high prices for the original apparatus, more or less crude and unsatisfactory, and in a short time it had to be replaced by a better grade, and this in turn has had to be replaced by more modern apparatus. What profits were made were promptly paid out in dividends and nothing was set aside for the replacement of apparatus. Depreciation was never thought of, hence the burden on the electric light plant is much heavier than on any other form of manufacturing plant. We do not want to stop progress in the electrical fields and fall behind the world which we are now leading. We want, on the other hand, to progress and to do everything possible to reach the maximum of economy in production and distribution of electricity so that its price may be reduced to a point where even the smallest storekeeper and the poorest family can afford to use it. Such a result can only be accomplished by leaving this in the hands of private companies and by the municipality helping the electric light plant in every way possible.

The trend of all argument on municipal ownership has been along the lines as to whether or not the municipal plant can be operated so as to furnish lights for the city at a less cost than the same quality and number of lights can be furnished by the existing company in that city. I say frankly that if the municipalities will adopt the same system of accounting as that in use by members of the National Electric Light Association, and which has been formerly adopted by that association, and carry such a system out faithfully in all its details, the municipal plant can not furnish light at as low cost, all things considered, as the city can obtain the same light from the local private company. The day of secrecy in the matter of accounting by electric light companies has gone by and there is not a single, modern, up-to-date plant in the whole United States which does not stand ready and willing to show to the municipality just what it costs to furnish it with its street lights and all it asks in addition to the actual cost is a reasonable mercantile profit. That every fair-minded citizen is willing it should have.

Aside from the cost and profit question, pro or con, there is a broad-minded view to be taken of the situation which may be summed up in a few words. Here is a comparatively new industry which is in process of development. Do the people of the United States as a whole want to encourage this industry and build it up and keep the United States in the van of progress by so encouraging it, or do they want to throttle it ? I believe that when people come to look at it in this light, the concensus of opinion will be strongly in favor of helping the industry in every reasonable way. If I am right in my belief, the question of municipal ownership of electric light plants disappears.

A Method of Prospecting for Mineral Ores.

The method of prospecting for mineral ores, developed by Messrs. Leo Daft and Alfred Williams, has been tested recently in Wales for zinc ores, and in Cumberland, England, for hematite. An alternating electromotive force of high potential, set up by an induction coil, is applied to two electrodes which are inserted in the ground. These set up an alternating current between them, and the direction of current flow through the ground is explored by means of two other electrodes and a telephone. If the ground is homogeneous, the equipotential lines determined will show no distortion; but if the conducting strata lie in the path of the current, this will distort the direction of current flow, and the location of this strata can then be determined. The method was used to locate the extension of a lode at the Cymystwyth Mines, which heretofore could not be found, due to faults, although tunnels had been run for this purpose. The electrical method located the lode without difficulty. It is stated that the influence of the water in the ground is not such as to prevent the method being employed. An improved form of breaker, operated by a motor, for exciting the induction coil, is used, with the latest type of apparatus. The system is thought to be particularly suitable for those classes of ore which occur in pockets.—*Abstracted from the Electrical Engineer (London), February 20.*

THE ESTIMATION OF COPPER IN ORES, MATTES, ETC.

BY O. H. PACKER, MINING ENGINEER, SAN FRANCISCO, CAL.

There are several methods for the quantitative analysis of copper ores and the products thereof, those in most general use being:

1. The electrolytic method.
2. The ammonia, cyanide method.
3. The iodide method.
4. The aluminum strip, cyanide method.

Electrolytic method—This has long been considered the most accurate and reliable method, and in the hands of able chemists it will be found perfectly satisfactory to the most critical and exacting, but when manipulated by the average mine assayer, especially with the apparatus usually employed in assay offices, it is far from accurate, to say nothing of the time required for an analysis. The following restrictions and limitations will make the above statement more convincing:

1. A uniform voltage must be maintained throughout the determination.

2. Too high a voltage will deposit spongy copper. It will also deposit zinc if present above three per cent.

3. If the solution is too strong with nitric acid some of the copper will remain in solution indefinitely. If too strong with sulphuric acid spongy copper is deposited.

4. Bismuth must be removed if present or it will deposit with the copper.

5. Zinc and lead are deposited if present above thirty per cent, therefore these metals must be removed.

6. Arsenic must be removed if present or it will deposit with the copper.

7. Do not stop the current before nor continue it after all the copper is deposited—other metals will be deposited in the latter case.

From the above it is evident one must know all the minerals present in the ore and be able to eliminate all objectionable elements present in the solution of the ore and determine when all the copper is deposited. This is requiring too much of the average assayer.

The ammonia, cyanide method—This is the method commonly in use in assay offices and chemical laboratories. Briefly stated, it is conducted as follows: The ore is dissolved in acid and the iron, usually present, precipitated by ammonium hydroxite and filtered out. The solution is then titrated with a standard solution of potassium cyanide. The method is subject to many causes of inaccuracy—chiefly the presence of elements affecting the titration and the retention of a considerable amount of copper in the iron precipitate.

Some chemists prefer to leave the precipitate of iron hydroxite in the solution to serve as an indicator, but as the per cent of iron is not the same in all ores, the practice is to be condemned, uniform results being almost impossible, especially with rich ores.

The aluminum strip, cyanide method—I expect the statement that this method is, for commercial purposes, as good as that of electrolysis, will be read by some with incredulity and surprise. In the hands of the average chemist and assayer it is certainly more to be desired than any other method thus far discovered.

This method is dependent upon the following chemical reaction, in which the copper unites with the potassium cyanide, forming the double salt of copper potassium cyanide.

$$CuSO_4 + 4KCN = CuK_2(CN)_4 + K_2SO_4.$$

The atom of copper in one molecule of copper sulphate reacts with the four molecules of potassium cyanide. That is to say, each atom of copper present in the solution will require four molecules of potassium cyanide in order to produce a stable and complete chemical balance.

The one atom of copper weighs sixty-three microcriths and the four molecules of potassium cyanide weigh $4 \times (39.1 + 12 + 14) = 260.4$ microcriths. We can, therefore, write the following proportion:

63 m.c. Cu : 260.4 m.c. KCN : : 1 gramme Cu : x grammes KCN.

Solving the proportion, we find $x = 4.1$ grammes. That is, one gramme of copper will react with 4.1 grammes of KCN. Therefore, if we make a standard solution to contain 4.1 grammes of KCN in each 100 cubic centimetres of solution, each c. c. of this standard KCN solution used in titrating an ore will represent one per cent of copper if one gramme of ore be taken for analysis.

Having explained the chemical principle and mathematics involved the details will be given below so explicitly that it is hoped one having had but a slight experience in chemical work will be able to analyze copper ores satisfactorily.

Standard copper solution—Wash a little over one gramme of chemically pure copper in slightly diluted nitric acid, heating gently. Wash the bright copper several times with distilled water and dry thoroughly by holding it about ten inches above the Bunsen flame upon a piece of paper. If supported over the flame by a metallic substance the copper dries too rapidly, forming a coating of copper oxide, thus increasing the weight. To keep the paper from burning one is obliged to dry it properly. The copper collected in "blue vitriol" gravity batteries, such as are used in telegraph offices, is sufficiently pure for all purposes. Do not use any of the original strip of copper furnished with the battery, as that is commercial or impure copper.

2. Weigh exactly one gramme of the C. P. copper, free from oxide. Dissolve in about 25 c. c. of slightly diluted C. P. nitric acid. Employ a tall beaker, or, better, an erlenmeyer flask. Heat may be used. A low beaker will permit a loss by fine spray falling outside the beaker.

3. Wash the solution into a litre flask and dilute to exactly one litre, using cold (63 degrees Fahrenheit) distilled water.

4. This standard copper solution can be kept indefinitely if distilled water has been used. Do not add any ammonia. Do not add a drop of water to it. Do not wash out burette with water alone, as the water adhering to the inside of the burette will weaken the standard. After washing the burette with water rinse it out twice with some of the standard copper solution, discarding the washings, of course.

5. Standard potassium cyanide solution—Dissolve about 42 grammes of the best commercial KCN in about half a litre of distilled water at 63 degrees Fahrenheit. Decant or filter out any sediment or "pus." Place in the litre flask and dilute to the litre mark. If made with distilled water this standard will not change very materially in several months, especially if kept from the light. It should be kept in a dark bottle. (See paragraph 27.)

6. Standardizing the KCN solution—As strictly pure KCN is not an article of commerce, the solution made according to paragraph 5 is not exactly standard. We must titrate a portion of our true standard, the standard copper solution, with the KCN solution to ascertain the actual strength of the latter.

7. Take two 100 c. c. burettes. Wash out one, first with water and then twice with standard copper solution. Fill this burette with standard copper solution, and run off to the zero mark.

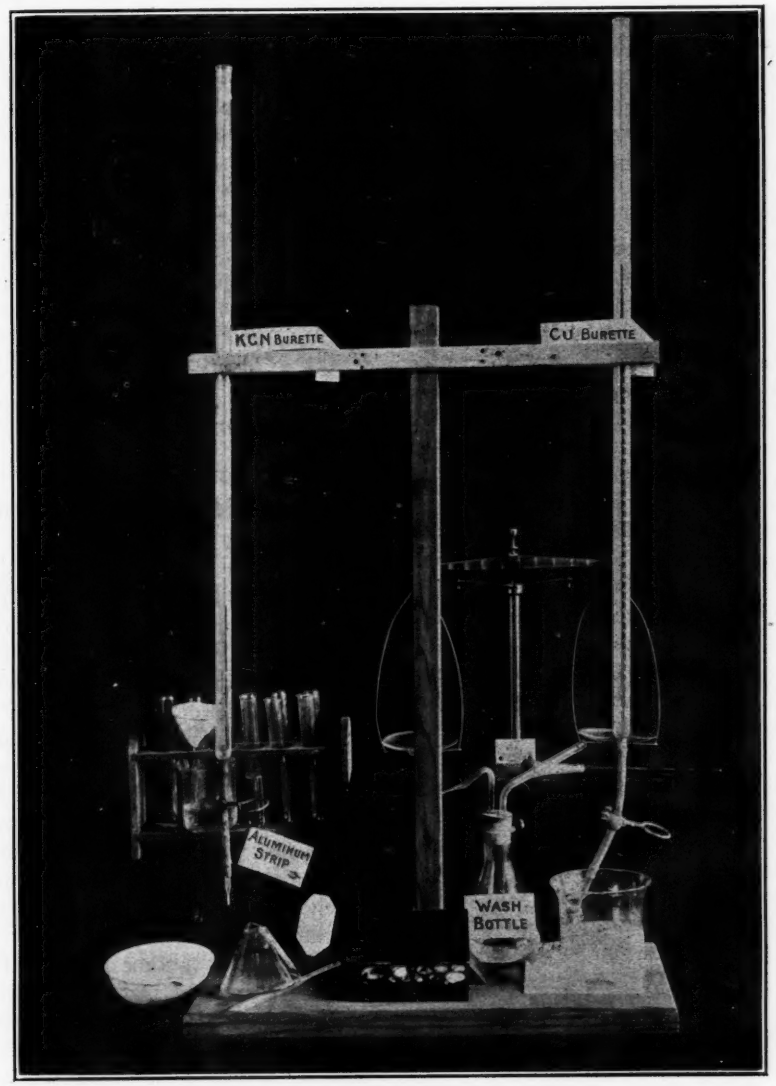
8. After rinsing out the other burette with the KCN solution, fill it and run off to the zero mark.

9. Run the 100 c. c. of standard copper into a tall beaker or erlenmeyer flask and add KOH solution to alkaline reaction (*i. e.*, till a slight precipitate of copper

hydrate is produced), and then add a little ammonium hydroxide which dissolves the precipitate producing a beautiful deep blue color. Place the solution beneath the KCN burette, having a sheet of white paper beneath it to aid in seeing the "end reaction." Add about 6 c. c. of KCN solution at once. When nearly 7 c. c. have been added, add KCN a drop at a time, thoroughly mixing each addition by stirring or swirling the copper solution. A light fading of the blue color gives warning that the "end reaction" is near, when one drop of KCN solution changes the blue to a light purple, and a few more drops produce a pink having no shade of blue. Whichever shade of end reaction be adopted must be adhered to in all future work in which this solution is used. Some chemists prefer the purple and some the pink end reaction, and in any case it will require some practice to recognize the exact shade. Some prefer to add KCN till the blue solution becomes perfectly colorless, but the practice should be discouraged, as the colorless end reaction is not nearly so sharp as the change from blue to purple or purple to pink. With a little practice one can tell the end reaction to within one drop of KCN, equal to less than 0.1 c. c.

The above titration should be repeated several times to ensure accuracy.

Multiply the number of c. c. of KCN used by 10, because one-tenth of a gramme of copper was in the 100 c. c. of standard copper solution used. This product, or "factor," is marked on the KCN bottle for future use.



Apparatus for Analysis and Assay of Copper.

10. The ore sample—Pulverize the ore to 100 mesh and dry. Weigh one gramme for moderately rich ores.

11. Place in a deep evaporating dish and cover with an inverted glass funnel having its stem broken off. Add 10 c. c. to 15 c. c. of strong aqua regia (two parts HCl to one part HNO_3). HCl or HNO_3 alone is sufficient if only carbonates are present. Heat gently on a sand bath until the minerals are decomposed and the bulk has been reduced one-half. Then add 10 c. c. of strong H_2SO_4. This must be added a little at a time. All additions must be made with the inverted funnel in place to prevent loss by spray. (See paragraph 31.)

12. Heat strongly until white choking fumes of SO_2 are copiously evolved. Only a small amount of sulphuric acid should now remain. Remove from the sand bath.

13. When perfectly cool add about 25 or 30 c. c. of water (funnel still in place). Wash down the sides of the funnel, inside and out, with a fine stream from the wash bottle and stir the contents of the evaporating dish till all the copper sulphate is dissolved.

14. Filter into a tall beaker and wash the residue.

(Treat residue with a little aqua regia in a separate beaker and add ammonia hydroxide to ascertain if any copper minerals remain undissolved. If solution turns blue add more aqua regia, boil, add H_2SO_4 and evaporate for fumes of SO_2 as before. Dilute, filter and add filtrate to last filtrate).

15. Place in the beaker a strip of metallic aluminum two inches by one inch by one-eighth inch in size and having two opposite corners bent down as legs so it will not lie flat on the bottom of the beaker.

16. Boil over wire gauze five to ten minutes, or one minute after the solution clears. (Not simply boiling hot.) This precipitates all the copper in the metallic state.

17. Quickly decant through a filter, retaining as much metallic copper in the beaker as possible. Wash the copper in the beaker quickly with water and decant through the same filter. Wash again; with a fine stream from the wash bottle drive off as much copper from the aluminum strip as possible. Place the strip on the filter paper, and place the beaker containing the metallic copper beneath the funnel. (Discard the filtrate as it contains in solution the metals not desired present when titrating. Test for copper before discarding.)

18. With an ink-dropper or a pipette drop strong nitric acid on the copper still adhering to the aluminum strip and to the filter paper, catching the copper nitrate in the beaker below. Add sufficient acid to the beaker to dissolve the remaining copper. Use no more acid than necessary. After making certain

that all the grains of copper are dissolved wash the strip and filter paper with water and dilute the solution of copper nitrate more or less in proportion to the amount of copper present. (75 to 100 c. c.)

19. Add KOH to alkaline reaction (slight precipitate) and about 2 c. c. of NH_4OH.

20. Titrate with standard KCN. If much aluminum hydrate is precipitated filter it out after about half of the cyanide judged to be required has been added. Avoid filtering if possible, as it is difficult to wash all the copper from the filter paper.

21. The number of c. c. of KCN used, multiplied by 100 and divided by the KCN factor, will give the per cent of copper in the ore, provided one gramme of ore was used for analysis. (See paragraph 9.)

The calculation can also be expressed in proportion as follows:

KCN factor : 100 % : : c. c. used : % of copper.

22. Example—One gramme of ore was weighed, dissolved and titrated with KCN, the factor of which is 94, 31 c. c. being required in titrating the ore. What was the per cent of copper in the sample?

$$94 : 100\ \% : : 31 \text{ c. c.} : x\ \%$$

$$x = \frac{100 \times 31}{94} = 32.9\ \%$$

23. Note that concentrated solutions require more KCN than dilute solutions, the per cent of copper remaining the same, and that a cold solution requires more KCN than a hot one.

24. In order to produce uniform results it is necessary to make all titrations at the same rate of speed, with the solutions at the same temperature and diluted in close proportion to the amount of copper present.

Use a sheet of white paper, or a white slab, beneath the erlenmeyer containing the solution to be titrated and view the samples in a similar manner when observing the end reaction—different shades of color are given by reflected and transmitted light.

25. If the above precautions are observed duplicate assays will agree within 0.1 per cent, and the ordinary metals present in ores will not interfere. (If much silver is present a few drops of HCl should be added before filtering out the residue, paragraph 14.)

26. In assaying copper matte take one-half gramme for a sample, for slag take three to five grammes, and for ores take from one to two grammes, depending on the richness of the ore.

27. Some chemists prefer to use a semi-standard solution of KCN—that is, of half strength, so that one-half the number of c. c. used will equal the per cent of copper in a one-gramme sample.

28. When dissolving an ore, do not add sulphuric acid at the same time the nitric acid is added. In titrating, use burettes having black enameled line up the back. Never use a float for clear solutions.

29. The best solvent for pyrrhotite is hydrochloric acid. This mineral is sometimes present in copper ores.

30. An excess of strong potassium hydroxide will precipitate the copper permanently, while if added in moderate quantity the precipitate first formed is redissolved in the ammonia hydroxide.

31. All copper minerals of commercial value are soluble in aqua regia, but some iron minerals are insoluble in hydrochloric acid and are left as a black residue mistaken for basic copper oxides, and sometimes insoluble copper compounds are produced by boiling the aqua regia solution down too low.

32. Numerous experiments have convinced me that the above method is strictly reliable and more uniform in results than any other volumetric method in use.

33. If desired, one can use NH_4OH alone to produce the blue color before titrating instead of using both KOH and NH_4OH. This does not give quite so sharp a reaction and more KCN will be required, so that unless the KCN standard solution has been standardized (against the standard copper solution) by the use of NH_4OH, the results will not check with results obtained by the use of both KOH and NH_4OH. In other words, the ore must be titrated by the same method and under the same conditions, in every respect, employed in standardizing the KCN solution.

All directions should be strictly complied with before finding fault with the method.

Experiments Concerning Very Brief Electrical Contacts.

At the recent meeting of the American Association for the Advancement of Science, Mr. Herschel C. Parker presented a paper giving the results of his work on brief electrical contacts. For this purpose a gravity contact key, devised by Dr. Charles Forges, was employed, the method being as follows: A condenser of known capacity was discharged during the time of contact, and the deflection on discharging noted. This deflection is proportional to the electromotive force and to the capacity, if a good mica condenser is used which has no absorption. The gravity key consists of a weight falling in guides, the key being furnished with a scale divided into fractions of a second, according to the law of falling bodies. This weight actuates the contact switches. Two may be used—one to break and the other to make the contact, giving times of contact varying from 0.4 of a second to 0.001 of a second. For shorter periods a single switch that makes and breaks the contact is used, and the time is made faster or slower by placing this in different positions on the scale. With this key it is possible to obtain a contact of only 0.000017 of a second, and with a careful adjustment it seems possible to reach 0.00001 of a second. Other types of contacts were used. In one, a steel ball suspended above a wire was allowed to fall against a steel anvil. This gave very positive and satisfactory results. It is interesting to note that, in work with condensers, the best mica condensers give no appreciable variation in capacity for the very briefest times of contact, while a paraffin condenser may show a reduction in capacity of about sixty per cent from the time of charge of 0.4 of a second to that of 0.001 of a second.

A New Use for Carborundum.

A new and interesting use has been discovered for carborundum, which has already found large employment as a substitute for emery. Capable of preparation only in a powerful electric furnace, where silica and carbon are fused together in presence of sawdust and common salt, carborundum is highly refractory; and it has been observed that a thin layer of the same substance applied to any other material of which furnaces are usually constructed, protects it from the heat and renders it almost equally refractory. Finely powdered carborundum is made up into a paste with water-glass, *i. e.*, sodium silicate, or some similar binding substance, and the paste is applied by means of a brush or otherwise to the bricks which are intended to be used for building a furnace, or those bricks are actually immersed in the viscid liquid for a certain time. If the furnace has already been built, the paste can be painted on to the exposed surfaces, giving one or more coats as may be desired. It is stated that a layer two millimetres thick will protect the bricks from the attack of the highest temperature which is ever produced by combustion methods in ordinary work. Examination of the bricks in such a furnace has shown that they had not suffered in the least. The skin of carborundum does not chip off, and is hard enough to resist mechanical injury.

New Form of Electrolytic Apparatus for Rectifying Alternating Currents.

Invented by M. Nodon, of Paris.

By Our Special Correspondent.

A STATIONARY apparatus which will rectify alternating currents and furnish direct or pulsatory current for operating motors, storage batteries, etc., has long been desired, but up to the present a successful apparatus of this kind has been wanting. A step in this direction, which seems to be of considerable practical importance, is the new transformer or "electric valve" which has been devised by M. Nodon, a prominent electrician of Paris. He uses a special form of electrolytic cell which acts as a valve and allows the current to pass in only one direction. The cell has been found to work well in practice and deliver a current which is sufficiently continuous to operate direct-current motors and charge storage batteries. For the latter purpose it will no doubt be especially valuable.

The principle upon which the apparatus is based dates as far back as 1874 when Ducretet pointed out the property which aluminum possesses when in an electrolytic solution of stopping one of the phases of an alternating current and allowing the other to pass freely. Leo Gratz experimented on the subject at Munich in 1897, and devised also an ingenious method of connecting the cells so that the two half phases could be collected so as to form a pulsatory current, which increased the efficiency considerably. In 1898 Pollak took out a patent in Germany for an electrolytic apparatus, using a solution of organic compounds, while in the same year Carl Liebenow, of Berlin, patented a current rectifier based on the properties of aluminum. These and other similar inventions did not prove successful for various reasons, such as low efficiency, excessive heating and waste of the metal. In 1899 M. Nodon took up the subject at the laboratory of the Sorbonne. He remarked that zinc and magnesium have the same properties as aluminum, but in less degree, and after making a series of alloys finally found that an alloy of aluminum and zinc in a solution of neutral phosphate of ammonium gave very good results, using iron as the inert electrode. The first cells, which were brought out at the Société de Physique last year, attracted considerable attention.

The apparatus reduced to its simplest form consists of an iron tube (see section Fig. 1) which is perforated with holes and closed at the lower part by an insulating stopper. The tube, which acts as one pole of the electrolyzer, is provided with a binding-post, C. In the interior of the tube is placed the cylinder, A, which is composed of an alloy of aluminum and

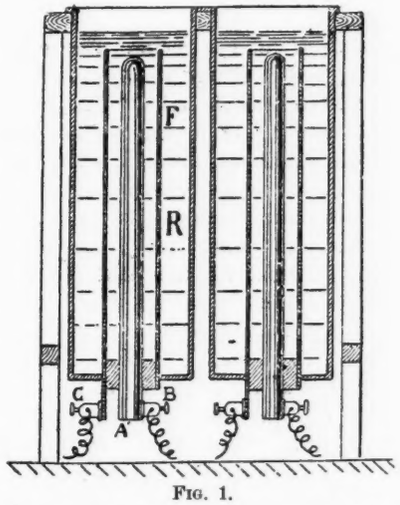


FIG. 1.

zinc. This cylinder passes through the stopper, being concentric with the tube, A, and carries the terminal, B. The whole is placed in a cylindrical vessel, R, through an opening in the bottom. The vessel contains a saturated solution of

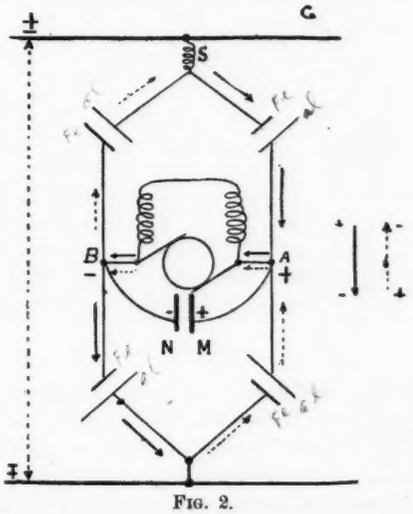


FIG. 2.

phosphate of ammonium. The action of this apparatus when traversed by the current is as follows: When the current arrives in the positive sense from the cylinder to the tube, there is instantly formed upon the surface of the cylinder a film of phosphate of aluminum and zinc, of alumina and of zinc oxide. This film, which presents an enormous resistance, opposes the passage of the current. On changing the direction of the current, allowing it to pass in the positive direction from the tube to the cylinder, the reduction of the film takes place and the current flows freely. A cell thus constructed acts, in fact, as an electric valve and allows the current to pass in only one direction. But with a single cell, supposing an alternating current to be applied to it, only one of the waves, the positive, would be utilized and the negative would be suppressed, the cell thus acting partly as an interrupter and partly as a rectifier of current. To be able to use the two waves of the cycle and in consequence obtain the effect desired, four of the cells are grouped according to the mounting devised by Leo Gratz, shown in Fig. 2, where the upper and lower wires carry the main alternating current to be rectified, and in the centre is a motor (or a set of accumulators, arc lamps, etc.) which receives the continuous current coming from the cells. The cells are grouped two above and two below the motor with their poles opposite each other, and an examination of the circuits, with reference to the above principle, makes it clear that the motor will always receive current in one direction. At S is a rheostat for regulating the current which may be also replaced by an inductive resistance. A condenser, NM, may be used in some cases, but is not essential. For electric valves of small capacity up to four kilowatts the voltage may be easily regulated at the terminals of the utilizing circuit by the resistance or self-induction coil indicated above; for valves which supply more than four kilowatts the regulation is best effected by insulating sleeves which are placed upon the zinc cylinders, shown at L in Fig. 3. This arrangement of insulating sleeves permits of obtaining always the same efficiency from the apparatus whatever the load, and thus gives it a marked superiority over the usual rotary devices for rectifying the current. Thus in the case of a motor-generator running at full load, from seventy to eighty per cent efficiency is obtained, but this becomes very low when running at light loads. It is found, on the contrary, that the electric values operate with an efficiency of seventy or

seventy-five per cent whatever may be the output. The measure of the efficiency which has been obtained by the wattmeter or by integrating the curves corresponding to the current and electromotive force

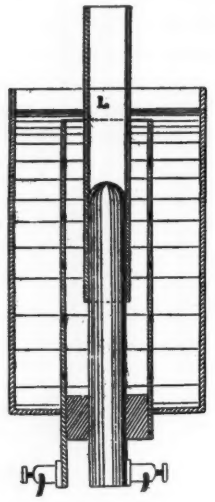


FIG. 3.

shows that the loss varies from twenty-five to thirty per cent. The loss of energy is manifested in the form of heat developed within the cell, and it becomes slowly heated to about fifty degrees centigrade, and then remains at a stationary point owing to the radiating action. The efficiency of the cell seems to be independent of the frequency of the alternating current used; thus at frequencies of forty-two, fifty-three and eighty-eight cycles the efficiencies were found to be practically the same.

The engraving (Fig. 4) shows the method of mounting which has been adopted in practice, the four elements being grouped together in a compact form and supported on a light framework. When the valve has not been operated for several hours, it is necessary to re-form the insulating film, and this is carried out in a very simple manner by starting with an alternating current of low voltage and gradually increasing it up to the normal, using for the purpose a rheostat or variable self-induction between the alternating circuit and the rectifier, as shown in the diagram. This operation, which lasts but a few seconds, is similar to the starting of a motor. The cells can stand a tension varying from 40 to 140 volts, and an electric valve will thus rectify an alternating current which does not exceed the latter voltage, while for higher tension two or more valves are mounted in series, as required. The dimensions of the rectifier are calculated in accordance with the density of the current per unit of surface exposed to the electrolyte, and experiments show that the current density averages five amperes per square decimetre of active surface of aluminum. In any case, the dimensions and weight of the valve are small in comparison to the usual rotary appliances used for rectifying the current. Its performance is best shown by the series of tests which has been made by M. Hospitalier, professor of electricity at the Paris Physical and Chemical Institute. The wave-forms were taken by the "ondograph," of which he is the inventor. The experiments were made at the college laboratory with a five-ampere rectifier, using a frequency of forty-two cycles coming from the city mains. The rectifier was used to charge a storage battery of forty-two cells in series. The wave-forms shown in Fig. 5 were obtained under these conditions, where E is the difference of potential (corresponding to the alternating-current mains), which is furnished to the rectifier, and I the corresponding current which is taken by the rectifier on the alternating-current side. The form of the rectified current is shown above the line, where e is the difference of potential at the terminals of the battery and i the corresponding current taken by the accumulators. It will be noted that the current is entirely rectified,

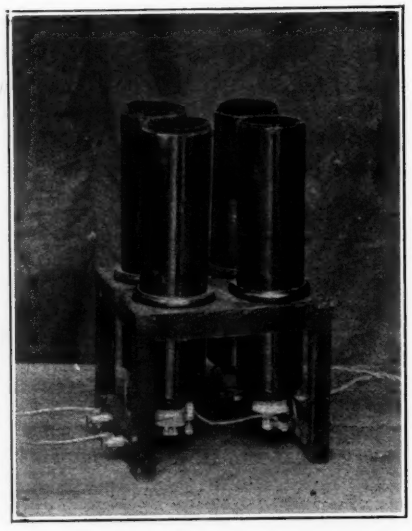


FIG. 4.

without any negative portion. The curve indicating the energy corresponding to these waves is seen at A in Fig. 6, while B shows the energy furnished by the rectifier to the battery. It is thus easy to find the efficiency of the apparatus by integrating the two curves throughout one period and the results show that the ratio of the areas varies in different experiments from sixty-five to seventy-five per cent, the difference being due to the rate of discharge, the number of accumulators, the temperature of the rectifying cells, etc.

A series of curves was also taken upon another of the city circuits which has the irregular electromotive force shown in Fig. 7 at E, with the corresponding current, I. The rectified current was used, in this case, to run a direct-current motor, and the electromotive force and current supplied to the motor (taken by the "ondograph") are seen at e and i. The

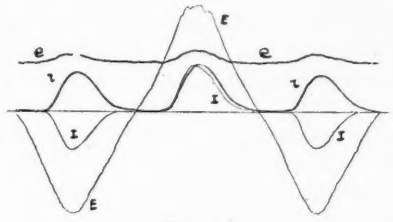


FIG. 5.

writer had occasion to observe the working of the rectifier in practice upon a Rechniewski motor of five horse-power, the alternating current being taken from the city circuit. In this case, the motor ran as usual, without any difficulty, on the rectified current furnished by the valve, and the same circuit was used to supply a number of direct-current arc lamps. At first a rectifier was used which had a capacity corresponding to the output of the motor, then another of much smaller size was substituted. The motor continued to run as before, the only effect observed being the rapid heating of the small cells.

An interesting application of the rectifier is in the case of three-phase currents, using a pair of cells per wire, or six in all, for a three-phase circuit. Instead of being simply rectified, as in the case of monophase current, the wave becomes undulatory and if the number of phases is increased (with the proper adjustment of cells) the wave approaches a straight line.

In practice this principle may prove of value, and it can be applied, for instance, to the excitation of a three-phase alternator which is furnished with direct current from the valve, using preferably a small transformer for reducing the tension to the proper point needed for the valve.

M. Nodon is commencing to manufacture the apparatus at Paris, and there is no doubt that it will find many applications, especially where the energy required is not too high; and for capacities below ten kilowatts, at least, it has the advantage of allowing the transformation of monophase or polyphase current into rectified

or continuous current with a cheap apparatus of strong construction and easily kept in order or repaired. It is not liable to short-circuits, and is compact and portable. One of the most promising applications is to the charging of accumulators from alternating circuits and the rectifier seems to be especially fitted for

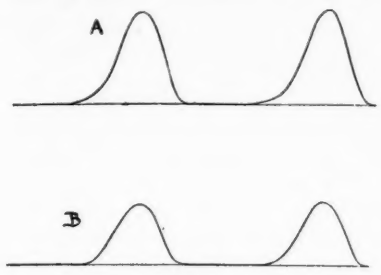


FIG. 6.

this kind of work. The engraving, Fig. 8, shows the method of charging the batteries of an automobile of the "Electricia" type. The alternating current from the switchboard passes first into a rheostat and then to the group of four electrolytic cells forming the rectifier. The rectified current is returned to the switchboard and sent to the batteries on the automobile by a flexible wire. The type of rectifier shown here uses the insulating

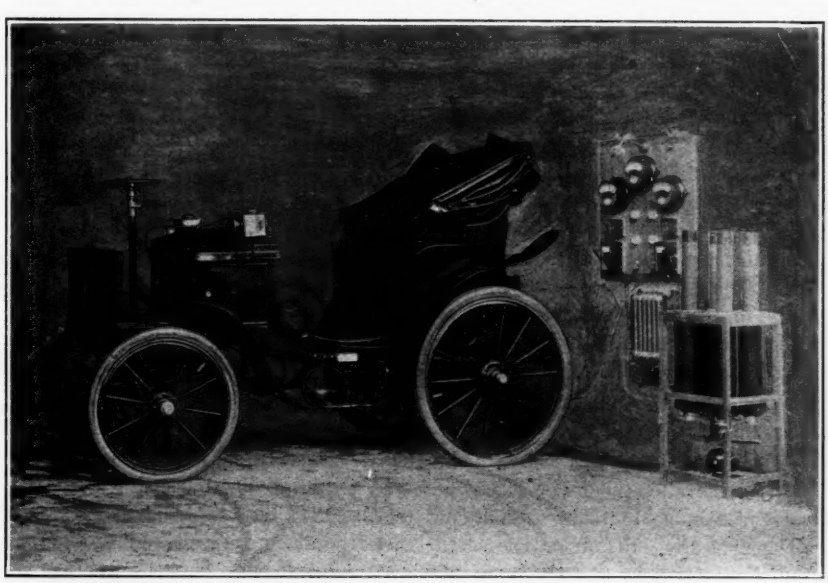


FIG. 8.

sleeves above mentioned, which fit over the inner metal rods and can be slid up and down to expose more or less surface to the electrolytic action, thus increasing or reducing the voltage of the direct current furnished by the cells without lowering the efficiency. The motor and air-fan which is used for cooling the larger types of apparatus will be observed on the framework below the cells.

C. L. DURAND.

Paris, France, March 1.

Ceara Rubber in Nicaragua.

Consul A. L. M. Gottschalk writes from San Juan del Norte, January 27, 1903:

"So much attention has of recent years been given to the cultivation of rubber at various points in Central America that the native rubber of the region, *Castiloa elastica,* is quite commonly regarded as the only species susceptible of cultivation in the country. In Nicaragua, the conditions exacted for its growth—hot, humid atmosphere, and a moist, though well-drained, soil—limit its artificial culture, as well as its natural growth, practically to the Atlantic Coast region.

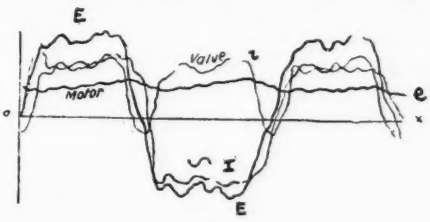


FIG. 7.

"In view of the popular belief that this region is Nicaragua's rubber district par excellence, and the consequent neglect of rubber culture in other fertile portions of the country, it is interesting to note that at La Paz, in the district of Leon, where precisely opposite conditions of climate prevail to what are needed for 'Central American' rubber—*i. e., Castiloa elastica*—another species, indigenous to Brazil, the 'Ceara' of commerce (*Manihot glaziovii*), is being successfully planted.

"The climate at La Paz is hot and dry and the soil of volcanic origin, retaining moisture during drought to within a few inches of the surface. Temperature averages from 80 degrees to over 100 degrees Fahrenheit. During periods of drought there is but little or no condensation of dew.

"In February, 1902, 'La Victoria' plantation was busy clearing a tract of about 300 acres from timber, vines and underbrush. Toward the end of May, after the first rains, planting of seeds in the open was begun. In June they had all sprouted, and in November of the same year the plantation boasted several trees as tall as twelve feet. This remarkable growth seems to obviate the necessity of nursery cultivation, the only care needed being to clean and keep clear from all weeds the seedlings till they are about twenty inches in height."

Ball-Bearings.

Ball-bearings are used to a considerable extent in the Horcajo Mines, Spain, and the experience which this company has had with this type of bearing is given by the engineer, Mr. P. H. Ziegler, in a recent number of *Engineering,* London. These are thrust-bearings used on the centrifugal pumps. The first type took up the thrust by means of a collar pressing against a slight shoulder on the shaft; but this caused excessive wear of the shaft and finally produced an irregular pressure upon the balls, wearing them greatly, and even breaking them. The bearing was then improved by extending the collar so as to form a sleeve, and keying this to the shaft, and then placing a second collar to bear on the first. These improved bearings, which are illustrated in the article, have given very satisfactory service. A record has been kept for the past two years, which shows all repairs which have been necessary. But two sizes of ball have been used—five-eighths inch and one-half inch in diameter, respectively. There were sixteen of the first per bearing, and twenty of the latter. Results from these have been almost analogous, but the half-inch balls have shown a little less wear than the others. Bearings with the half-inch balls are less rapidly heated than those with the five-eighths inch balls. In some cases a set of balls has lasted 289 days before renewal was necessary. The life of the bearing depends greatly upon the quality and tempering of the bearing and the balls.

Long-Distance Telephony.

A long-distance telephone line was put in service between Rome, Milan and Turin on February 15.

Notes from Great Britain.

By Our Special Correspondent.

ONCE more has the old problem of the regulation of the traffic in London been tackled by the government, and, probably, in consequence of the fiasco which happened last year in connection with the tube railway schemes, a royal commission has been appointed, and the terms of the reference to it are extremely wide. The commission has to do no less than enquire into the means for expediting, first of all, the pedestrian and vehicular traffic, tramway and railway routes, etc., and to report upon the desirability of appointing a central authority to which all tramway and railway schemes should be submitted in preference to allowing them to be dealt with by Parliament. On the surface, and before the royal commission has commenced to sit, the work it will entail appears likely to last for some months, and the next thing which is looked for is the announcement that all tube schemes which should come before Parliament this session will be postponed. If this happens, we appear to be in for a repetition of what happened in 1901, when a joint committee of the House of Lords and the House of Commons hung up all the tube railway bills for a year and made practically no suggestions for dealing with the problem of any value. Except that the present royal commission has a much wider range of operations, it is difficult to perceive any fresh suggestions as regards the railway and tramway side of the problem; but, of course, in such a tribunal the engineer element is much more in evidence than in a parliamentary committee. From the general public knowledge of a few of its members, however, it is quite certain that more than one member has quite original views on the subject.

I recently announced that the British Thomson-Houston Company had received a large contract in connection with the conversion of the North Eastern Railway Company to electric traction. The company now announces that another contract has been awarded to the British Westinghouse Company for the supply and erection of the high and low-tension switchboards, rotary converters, stationary transformers and all the substation equipment. The conversion of the Mersey Railway by the latter firm is now practically complete. Each car is equipped with four 100-horse-power motors, the Westinghouse electropneumatic system of control being employed. The weight of the motor cars is about thirty tons, each of the trailers weighing about eighty tons. The generating station has nine Stirling water-tube boilers, five engines, and three 1,200-kilowatt dynamos and two 200-kilowatt dynamos. Double-current generators are employed. It is expected that the electrically worked trains will be put into operation in about a month's time, when a three-minute headway will be maintained for a greater portion of the day.

In connection with the electrification of the Inner Circle, the Metropolitan company has made several contracts for its portion of the equipment. Its power-house, which will also supply power to all its other lines when converted, is now in course of construction at Neasden, in the northwest of London, and the British Westinghouse Company will supply the whole of the generating machinery, which will aggregate 14,000 horse-power. The contract specifies that the whole of the equipment shall be in running order by November 30, 1903. Sufficient room is available on the site of the works to extend to the extent of another 5,000 horse-power. The contracts for cars, conductor rail and all other portions of the equipment have all been let, and it is expected to have electrical trains running by the end of this year. The District company, on the other hand, is soon to be running experimental electrical trains, so that the long-looked-for transformation of the renowned "Circle" is now well within sight.

In the meantime, the other electrical railways continue to show profitable working. The Central London has again paid its four per cent, and shows an increase in receipts of £12,747 over 1901. As a matter of fact, the line has earned five per cent, but the company has an expensive bill for extensions before Parliament, so that the wisdom of the directors is not questioned. The latest endeavor to improve the ventilation has been to erect a huge electric fan at one end of the line, and, by closing all the station entrances at night, and setting the fan at work, it is claimed that the tubes will be thoroughly purified before the morning service begins. The substitution of motor coaches for locomotives is gradually being accomplished, and one is actually now working. This has been done in order to comply with the wishes of the Vibration Committee.

Thus early in the year we have had two motor car exhibitions in Great Britain, but again the result has not been altogether satisfactory. The first one produced absolutely nothing worth speaking about in the way of electrical cars, but the second one was better. Besides several makes of American cars, such as the Baker vehicles, a number of European and home-made automobiles was shown for the first time. Among the latter was a two-seated accumulator car built by Messrs. Prikletts & Gold, a British firm of secondary battery makers. The battery is forty cells, which is divided into two for convenience. The battery will sustain a run of forty miles. Another home firm is the City & Suburban Electric Carriage Company, but inasmuch as the company has no selling rights in America, it does not encourage description. On its stand, however, it had an omnibus, landaulets, broughams, etc., and a combination petrol-electric vehicle. In the latter a small petrol engine drives a dynamo and charges a battery, and in spite of this comparatively large amount of machinery, the external appearance of the car is distinctly pleasing. Another similar car came from the Continent, while a new arrival in Great Britain was the "Contal" car, which also comes from the Continent. The battery is forty-two cells, having a capacity of 135 ampere-hours, with sufficient power for a fifty-mile run. The motor is a five British horse-power, on a continuous load. Magnetic points are avoided by a very compact arrangement of field castings and bobbins, the final result being a total suppression of sparking. The battery is underslung, one of the chief advantages of which is that any acid fumes given off can be readily disposed of. Altogether we have now more electrical cars in Great Britain than at any other time, but I do not know that the demand at present is very great.

That good progress is being made by Mr. Yerkes in his scheme of electrifica-

tion of London underground railways is borne testimony to by a public issue of some $10,000,000 of Great Northern, Brompton & Piccadilly Railway stock. This line is an amalgamation of the Brompton & Piccadilly Circus Railway and the Great Northern & Strand Railway, and it will now serve to connect, by an underground tube-railway, the northern suburbs with those in the southwest. The power-house for this railway is the 50,000-kilowatt one at Chelsea, which the Underground Electric Railways Company of London is building for the supply of electrical energy to all the railways taken in hand by Mr. Yerkes. Just about now, too, rumors are current that an amalgamation between the District Railway Company and the Metropolitan Railway Company, the two concerns working the Inner Circle, is imminent, and although the Board of Trade has forced the direct-current system upon the two companies as regards the Inner Circle, more harmonious relations are not undesirable. The first of the Yerkes tube railways to come into operation will be the Baker Street & Waterloo line, in about twelve months time. At present, also, experimental trains are being run by the District company a little way out of London upon a short length of line which has been specially fitted up for this.

The supply of cheap "power" gas has been greatly boomed during the past two years in Great Britain, and as a competitor of electricity for power purposes it is not to be despised. Among the parliamentary bills for the coming session is one in which the two forces are to be supplied by one company, which proposes to give a supply of both gas and electricity for wholesale purposes only; *i. e.*, no private consumer will be supplied. The area chosen lies about Derbyshire and North Wales, close to Liverpool and Manchester, and it is the first proposal of its kind.

The London County Council is ever bringing down upon itself the wrath of some one. The question of municipal trading, always nowadays more or less attracting attention, has received a little fillip by a bill which the Council is promoting this year, empowering municipalities in London to undertake the electric light wiring of houses, etc. The London electrical contractors are up in arms against this proposal, urging the unfairness of having to pay rates to enable the Council to embark in a business competitive to their own. When it is further stated that the bill in question wishes to authorize the borough councils in London to wire free of charge for the time being new buildings which might eventually be rented by prospective customers, the amount of work thus taken from the small wiring firms will be considerable. This seems to be one of those instances in which municipal trading is overdone, and the impartial advocate of both municipal and company trading takes the contractors' side in this matter. It was only by the intervention of the Local Government Board, when enquiring into applications for municipal loans, that local bodies were forced to seek powers to carry out wiring and the hiring out of motors, etc., as hitherto this business was carried on illegally.

The original tube railway in London—viz., the City & South London Railway—continues to be maintained in a flourishing condition. During the half year ended December 31, 1902, 9,877,199 passengers were carried, an increase of over 2,000,000 over the half year ended December 31, 1901. A five per cent dividend will be paid on the preference shares and three and one-half per cent on the consolidated ordinary stock. Some $250,000 was available for distribution as dividends, and $6,000 was carried forward.

The London Limited Tramway Company, too, the pioneer of electric tramway traction in London, is also proving even more successful in point of size and figures. It has now been decided to increase the capital from about $4,000,000 to $5,000,000. The recent alliance with Mr. Yerkes and his cofinanciers is considered a good piece of business for the fortunes of the company, and the through bookings from tram to tram will, no doubt, be appreciated by the traveling public.

At last has some result of the tenders submitted for the electrification of the North Eastern Railway been made known. A large portion of the work has been put into the hands of the British Thomson-Houston Company. The railway company will make the coaches itself, but has ordered equipments for fifty motor cars and fifty trailers. These equipments will be on the multiple-unit system, similar to that employed on the Great Northern & City Railway and the Central London Railway. Locomotives for goods traffic will also be supplied by the British Thomson-Houston Company, which will further carry out the necessary alterations to the track, including the provision of the collector rail and the bonding. The total length of line to be converted is some thirty-five miles, double track, mostly for passenger service.

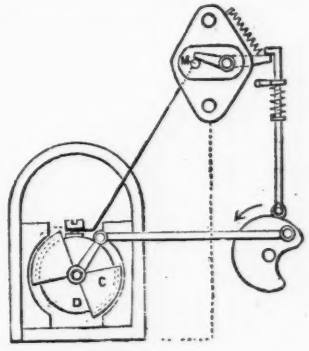
Some interesting statistics were given in a paper dealing with electric automobiles before the Institution of Civil Engineers recently. The author stated that in London there were over 16,000 licensed horse carriages, apart from private vehicles, etc.; there were over 200,000 horses stabled each night, and that there was a daily removal of over 5,000 tons of refuse and manure from the streets. Coming to the practical part of the paper, the same bemoaning the laxity of the British in developing the electric motor car industry was heard, as has been drawn attention to in these notes more than once, and in spite of three exhibitions this year, one of which has already been held, there is no reason to anticipate any better state of affairs.

A. W.

London, England, March 1.

A New Igniting Device for Automobiles.

The current issue of the London *Electrical Review* describes a new igniting device which was exhibited at the recent automobile show at the Crystal Palace, London. This device consists of a small magneto. The field is composed of a number of permanent horseshoe magnets, placed side by side, and mounted on an aluminum or gun-metal base. Pole-pieces are fixed between the extremities, and are



NEW IGNITING DEVICE FOR AUTOMOBILES.

bored out to admit the H-shaped armature core and oscillating field. The armature is immovable, one end of its coils being fixed to the base, and the other to the sparking plug on the engine. Sparks are produced by giving an oscillatory motion to the soft iron shield, which partially envelops the armature. This alternately forces the flux through the armature, and then causes its withdrawal. The oscillating shield is linked to the cam which makes and breaks the sparking circuit on the engine. The mechanism breaks contact when the shield is central and the field through the armature is most fully intercepted.

Electrical Equipment of Iron Works.

Realizing the necessity of adopting the most approved methods of power transmission, Sir B. Samuelson & Company, Limited, an old and prosperous firm, has during the past summer installed an electric transmission plant, including entirely new and modern apparatus, both in the driving appliances and the other machinery in its works at Newport, in the outskirts of Middlesbrough, England. The contractor for the electrical power installations is the British Westinghouse Electric and Manufacturing Company.

The power is generated in the form of three-phase alternating current by two steam-driven Westinghouse alternators of the rotating armature type. The steam engines run non-condensing, and at a normal speed of 400 revolutions per minute. Steam is supplied at a pressure of 150 pounds per square inch by four Babcock & Wilcox boilers. The boilers are heated by the waste gases from a battery of coke ovens alongside, being placed between the ovens and a lofty smokestack. The flues are duplicated and fitted with dampers and by-passes, so that any number of the boilers may be heated and regulated as required. Steam-driven pumps supply water from the Middlesbrough and Stockton water supply system. Injectors are also fitted to each boiler, and a Berryman exhaust steam feed-water heater is included in the steam equipment.

The construction of these alternators ensures the best of insulation being obtained, and also renders possible the easy examination and replacing of any single armature coil without interference with the rest of the winding. The output of each generating set is 175 kilowatts at 440 volts pressure. All of the motors and the electric lighting are supplied direct from the machines. Although rated at 175 kilowatts, the alternators have a considerable overload capacity, and are able to maintain twenty-five per cent overload for long periods and fifty per cent overload for about an hour, without undue heating or chance of injury. Each machine has an exciter, driven by belt from the outer end of the main shaft. The two exciters are similar, of four-pole type, and each has a capacity of seven and one-half kilowatts at 125 volts, when running at a speed of 775 revolutions per minute. Each of these machines is capable of providing full exciting current for both alternators running at maximum rated load.

The main switchboard consists of six white marble panels supported on wrought-iron framework at a distance of five feet from the engine-room wall. There are two machine panels, one exciter panel and three feeder panels, all being fitted with standard instruments, switches, etc. The machine main circuits and also the feeders of each of the four sets are fitted with fuses. Each of the three feeder panels carries switches and fuse blocks for two sets, one feeder panel thus being available for extensions. The circuits are arranged for the parallel running of the main generators, which, with their exciters and switchboards, are housed in a new building erected for the purpose.

Electric power is used for the rapid handling and breaking of the coal, two motors being installed in the building set up for the accommodation of the coal breaker and elevator gear, these two machines working together and taking complete charge of the coal supply, reducing the labor item to a minimum. The capacity of this portion of the equipment is fifty tons of coal per hour. Another electric motor is installed in a shed at the base of the middle storage bin at the lower end of a conveyor belt which carries the coal at the rate of about twenty-five to thirty tons per hour up an angle of seventeen degrees. The fine coal is fed into the coke ovens through top doors from small wagons having collapsible bottoms so as to permit of rapid work in charging. The coke is taken from the ovens by means of an electric ram, through a vertical sliding door at each end of the ovens.

An electrically operated overhead crane of seventy-foot span travels over the full length of the casting bed and has a lifting capacity of four tons, the power being received from three independent motors, giving a speed of 320 feet per minute. This crane lifts the cold pigs in "comb" pieces of two tons or more in weight direct from the casting bed, and carries them to an ingenious breaking machine installed on a raised brick platform. The pigs, as brought forward by the crane, are laid on a long iron table which has a loose centre to which an undulating motion is given for lifting the long "comb" of the pig forward as it comes under a set of rams. Two rams descend and grip the outer sides of the pig by pressing it down on the solid table, a middle ram follows, striking the hollow centre of the pig and breaking it into three or four pieces. The pigs are broken into lengths of about two feet each and fall down a short open chute into railway cars below. The breaking process and the wagon loading are continuous and automatic. Another ram behind those mentioned serves to break the sow piece as it gradually works its way forward from the gripping ram of that side. All the motions of this machine, both those of the table and the rams, are produced by a single electric motor, which is coupled to the breaker through spur reduction gearing.

The nine electric motors for the purposes described are all exactly similar in construction, and in every case, it is stated, have behaved remarkably well under unusually trying conditions. They are three-phase, alternating-current induction motors. With the exception of the three crane motors, which require to have a certain amount of regulation, the motors are each started by means of a double-throw switch which may be some distance from the motor if desired.

The crane motors are started and regulated by means of commutator-type controllers. The set of these, for all three motors, is fixed in the operator's cage, which is suspended from the crane at the pig-breaker end, where the man in charge is in the most advantageous position for performing his work of laying pigs quickly and correctly on the breaker table. The controllers are simply designed on an extension of the principle of the starting switch mentioned, having a number of intermediate contacts for supplying various electrical pressures to the motors.

The motor standing at the foot of the fine-coal storage bin works constantly in an atmosphere charged with coal dust, frequently being embedded in an accumulation of fine coal, and when it is cleaned out periodically a large quantity of coal is taken from it. Still it works constantly and well, never receiving any attention beyond a periodical cleaning and an occasional visit from the greaser. The two motors installed together for the operation of the coal-breaker and the bucket elevators are subject to similar conditions as the one just mentioned, although to a somewhat less degree.

The motors working the coke rams are subject to high temperatures. The heat radiating from an open oven is very great, even at the distance the motor is away from the oven face. Yet these motors, as well as the crane motors which are exposed to atmospheric effects and changes, perform the heavy duties required of them in a manner so satisfactory that it is not difficult to understand their individual reputation and the impetus they have given to the installation of electrical equipments throughout the world.

The power station is lighted by a number of incandescent lamps arranged in

pairs across the 440-volt supply mains. There are, also, 120 incandescent lamps and twelve arc lamps of the enclosed type distributed in various parts of the works. The lighting system is about to be extended considerably.

The immediate effect of the electric crane and breaker for the handling of metal at the casting beds was the reduction of the staff to the extent of twenty-three men. The introduction of electrically driven machinery has not necessitated the employment of new and highly trained workmen. With the exception of the power station, where the steam plant and the control of the generators and circuits call for a certain amount of skilled labor, no work of attendance beyond the ability of the untrained man of ordinary intelligence is required. The men in charge of the electric plant have been drawn from the former staff.

Report of the Bureau of Steam Engineering, Navy Department, Washington, D. C.

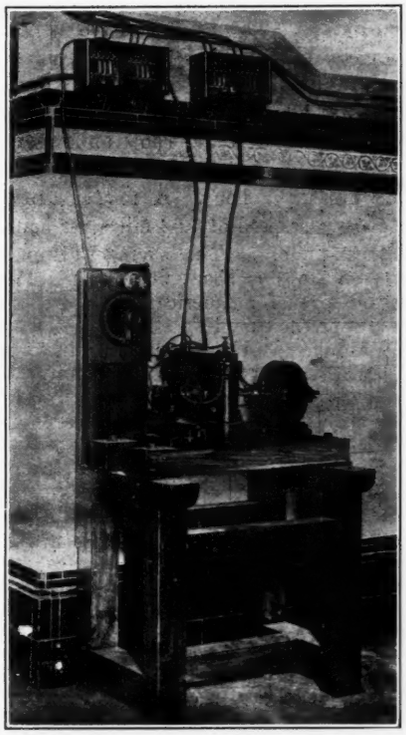
A report of the Bureau of Steam Engineering, Navy Department, for the year 1902, contains results of an elaborate series of tests with the Hohenstein boiler. A model plant was set up, the conditions approximating as closely as possible those obtaining on naval vessels. This plant included a Hohenstein experimental boiler, enclosed in a steel compartment, with all necessary appliances. The work included comparative tests of coal and oil made with this boiler. Severe tests with coal demonstrated that the boiler has the endurance and efficiency of any water-tube boiler used in a foreign battleship. Careful measurements were made of the temperature of the gases in various parts of the furnace. Natural and forced draughts were employed. After completing the tests with coal, it was decided to place the boiler at the disposal of manufacturers of oil-burning devices, and this has been done in a number of cases, and the work is still going on. The report gives the results of several of these tests, and states the conditions under which they must be made. It is thought that by making these tests with oil with a boiler that has been tested with coal, comparative results of much value will be obtained. The bureau has also investigated the use of oil for fuel on ships, and has come to the conclusion that while this may be desirable for merchant vessels, it does not seem desirable for naval vessels which do not ply between two fixed ports.

A MODERN ELECTRICAL EQUIPMENT OF AN ENGLISH INFIRMARY.

BY FRANK C. PERKINS.

One of the most recent as well as most interesting applications of electricity in an English infirmary is that of the North Staffordshire Infirmary, the new installation of which was inaugurated by the Duchess of Sutherland a few weeks ago. The necessary power for the operation of this electromedical plant is supplied from the power plant of the Potteries Electric Traction Company, whose mains pass near the building.

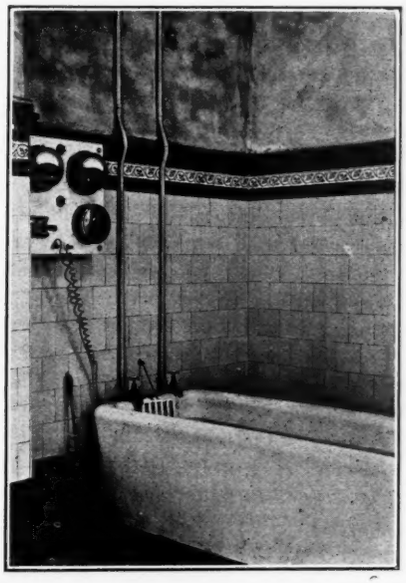
The current is utilized by charging a storage battery installation consisting of twenty-eight chloride accumulators, each cell having a capacity of sixty amperc-



MOTOR ALTERNATOR AND DISTRIBUTING BOARD, AT ENGLISH INFIRMARY.

hours. The various rooms containing the X-ray apparatus, the large electric bath and controlling board, as well as arm baths and other electromedical apparatus, are shown in the accompanying illustrations. The arrangement of the apparatus was designed by Dr. Armstrong, of Buxton, and the plant was installed by Marshall & Woods, of Gray's Inn road, London.

The batteries are connected in series, and in three of the rooms resistance is obtained by several five-light fittings, while a double-throw switch is installed in order to make it impossible to make connections with the battery when it is being charged. Five circuits are carried to the electric baths from a six-way double-pole junction board, while another circuit supplies a small one-third horse-



LARGE BATH AND CONTROLLING BOARD, AT ENGLISH INFIRMARY.

power motor-generator, the dynamo of which is an eight-pole alternating-current machine, supplying two amperes at fifty volts.

This motor-generator set is also connected to a board with five circuits to the electric baths, allowing alternating current to be used when desired. The fuses are used in the motor circuit only, and not in the alternating-current lines to

SWITCHBOARD AND ARM BATHS, AT ENGLISH INFIRMARY.

the baths, which, if interrupted by the blowing of a fuse, might give a severe shock to the patient. If the motor circuit fuse is blown the high speed of the

motor and the momentum of the armature would prevent a sudden shock to the person taking the bath.

The five circuits connect the batteries and motor-generator to several large electric bathtubs and small arm and foot-baths, and either alternating or direct current may be used at will by operating the proper switches. The controlling board is designed so that the outer terminals of the double-pole, two-way switch are joined to the first pair of terminals of the alternating and direct-current connecting boards. The centre terminals are connected through two twenty-five-volt, five-candle-power lamps to the ends of a resistance of about 250 ohms, while the bath terminals are connected to the rheostat and to an arm which makes a sliding contact.

A very gradual cutting out of the resistance gives good regulation, and the heavy rush of current from short-circuits in the bath is prevented, and unpleasant effects from accidental interruption of the bath circuit are largely obviated. The controlling switchboard is supplied with a voltmeter reading to fifty volts, and a milliampere-meter reading from 0 to 300 milliamperes.

The controlling boards for the arm and foot-baths are similar to the large baths, as noted in the illustrations, except no measuring instruments are used. The baths are of porcelain and the electrodes are of tin and copper in wooden frames, with the usual binding-posts. In addition to the instruments shown in the view of the large electric bath, an ammeter and voltmeter for measuring the alternating current used have been installed.

The battery is also utilized for supplying lights for the operating room, as well as such current as is required. It is stated that the main object of the electric baths in this infirmary is to treat the many cases of paralysis due to lead poisoning. A large number of the patients of the North Staffordshire Infirmary is afflicted with this trouble, as a certain class of pottery workers is very liable to have this terrible disease and it is to cope with the paralysis due to this lead poisoning that this installation has been equipped.

The Rœntgen ray apparatus was installed in this English infirmary by Mr. L. Miller, of Hatton Garden. This apparatus consists of the usual fluoroscope photographic apparatus, X-ray tube and coil. The ten-inch coil is operated from a portable set of storage batteries charged through a four-pole, double-throw switch.

The special arrangements of the storage batteries, obviating the possibility of the patients receiving a shock from the 500-volt charging railway line, was designed by Mr. Frank Miller, of the Potteries Traction Company, who also had charge of the installation of the entire plant. The electric baths are expected to be of great advantage to the sufferers from lead poisoning in North Staffordshire, although the number of cases is not at present so large on account of the new factory acts recently adopted in England.

The Speed of Electric Cars in the United States and Abroad.

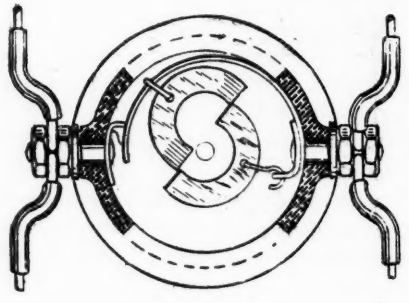
The Association of Municipal Tramway Managers of Great Britain, at the request of the British Board of Trade, has compiled some statistics relating to the speeds of tramway cars in this country and Europe. The tables are not as yet complete, but some of the data secured may be of interest. Figures obtained from the electric railway companies of England and Scotland show an average speed, including stops, for city routes of 6.68 miles per hour. A few suburban lines have a speed of 7.02 miles per hour, including stops. The average distance between stops is about 200 yards. The figures given for American roads are not by any means complete. These show that the average speed of the railways in some of the principal cities in this country is 8.13 miles per hour for city routes. The average speed for suburban roads is 16.67 miles, both including stops. The statistics for towns in the continent of Europe are quite complete, and show an average speed of 7.2 miles per hour within the city, and of 9.6 miles on suburban roads, both including stops. The average distance between stops varies considerably, the maximum being about 327 yards, and the minimum, 173 yards.

Journal of the British Institution of Electrical Engineers.

The February issue of the *Journal* of the British Institution of Electrical Engineers has been received. This is a valuable number of the *Journal,* for it contains three notable papers: President James Swinburne's address, upon "Some Limits in Heavy Electrical Engineering;" Sir Oliver Lodge's paper, "On Electrons," and Dr. J. A. Fleming's paper on "The Photometry of Electric Lamps." A fourth interesting paper is that by Messrs. R. S. Hutton and J. E. Peteval, upon "High-Temperature Electrochemistry, Notes on Experimental and Technical Electric Furnaces." Mr. F. Gill contributes a short note upon "A Hydroelectric Phenomenon," and there is also a form of model general conditions for electricity works contracts. The issue is quite large, containing, as it does, 276 pages.

Electrical Patents.

A novel thermostat for automatic electric fire-alarm systems has been patented by Mr. John M. Latimer, of Philadelphia, Pa., and the patent obtained thereon has been assigned to the United Pneumatic Fire-Alarm Telegraph Company, of New York city. The idea of the inventor is to provide a device which is reliable in action, it being in normally open circuit and so constructed that it is extremely sensitive to the action of heat caused by fire in the room wherein the thermostat is located. A casing or box is employed, which is composed of a base-plate, upon which is seated a hollow cap having its outer end open, these parts being secured together by means of a central spider frame and a bolt passing therethrough and through the base. Binding-posts pass diametrically through the cap and are threaded at their outer ends for suitable nuts, which secure the line wires forming a part of the electric fire-alarm system.

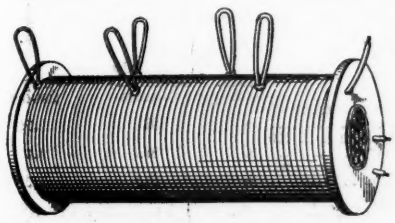


THERMOSTAT.

The inner ends of the binding-posts support upon the inner wall of the cap or hollow member fixed and movable contacts, respectively, for closing the electric circuit. The fixed contact consists of a piece of metal fastened to the inner end of one binding-post and provided at one end with an out-turned lip, the movable contact being in the form of a curved spring fastened at one end to the other post and being arranged to move into engagement with the fixed contact lip. It is normally held out of such engagement, however, by a fuse member, consisting of two semi-circular sections fastened together by soft solder, one of these sections being secured to the free end of the spring to hold it out of engagement with the fixed contact, the other end being suitably connected with a hook arranged upon the inner face of the cap. The parts while enclosed in the casing are so arranged that hot air can have free access thereto, and thus when a fire occurs the heat thereof will act upon the fuse, and melting the solder will free the sections

from each other. As a result, the movable contact will spring into engagement with the fixed contact, thereby closing the electric circuit.

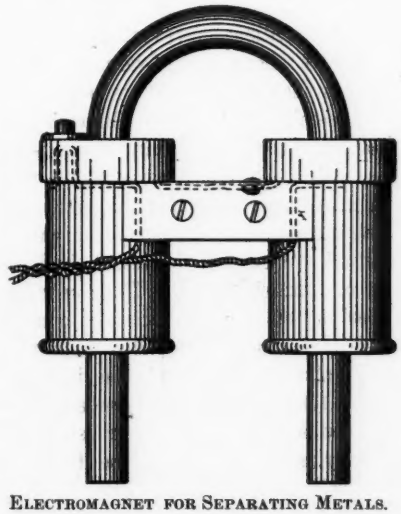
A transformer for changing the voltage of an alternating electric current has been invented by Messrs. Otis J. Depp and James P. Hunted, both of Dallas, Tex. The transformer is intended more particularly to admit of varying the voltage of an alternating current to supply a lamp or group of lamps of low voltage capacity, such transformer being simple of construction and consequently comparatively inexpensive of production. An iron tube is used, which is slotted longitudinally from end to end and encloses a Swedish iron core made of a number of strands of wire or laminations of soft iron. The slot receives a spacing strip of fibre or other non-conducting material, which prevents the walls of the slot from coming together. Around the com-



TRANSFORMER.

pleted core is placed suitable insulation, over which is wound the insulated magnet wire, forming the primary coil. The coil is covered with insulation, and upon the same is wound the secondary coil. The secondary coil is provided with a series of loops or branches connected to different convolutions thereof, from which a number of leads may be connected to proper terminals, so that by means of a switch several voltages can be obtained from the secondary coil. When used for controlling miniature lamps, for which the device is primarily designed, the voltage may be stepped down from 110 volts to one volt and up to ten, in as many divisions as may be required. It is possible, however, to use a lower primary voltage and obtain a correspondingly low voltage from the secondary wire.

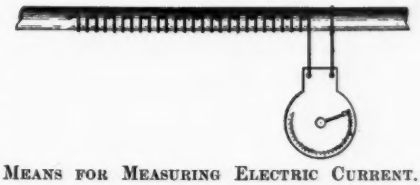
A novel electromagnet has been patented by Mr. George H. Young, a resident of Elmira, N. Y. The object of the invention is to provide a powerful and effective hand-manipulated magnet at a low cost for separating iron and steel filings, cuttings, dust and the like from brass or other substances in which they may be loosely held or intermixed. A steel or soft iron bar, preferably round in cross-section, is employed, and is bent into the form of a U, or, in other words, horseshoe-shaped. This bar forms the core of the magnet, the two ends constituting the positive and negative poles thereof. Upon each leg is a spool wound with wire in the usual manner, the outer coils being covered by a moisture-proof jacket. Two wooden blocks are clamped together between the spools, and the two ends of the wire cable are led into the spools through suitable grooves provided in the ends of one of these blocks. The wire running from one spool to the other is carried along the inside of one block and thus the wires are protected from breakage or other damage. Two washers of fibre or other non-conductive material form the upper ends of the spool, and in one of these washers is a suitable socket within which is placed a push-button switch for making and breaking the circuit. The bend of the core-bar forms the handle of the magnet, and the location of the push-button is such that it may be readily manipulated by the thumb, and the finger of the hand grasping the handle. In operation the wire cable leading to the magnet is attached to any source of electric current supply, either to a dry cell or other battery or to an electric light circuit of either direct or alternating current. The handle is then grasped by the hand with the thumb or finger pressed on the push-button to establish the cur-



ELECTROMAGNET FOR SEPARATING METALS.

rent through the magnet coils, thereby exciting the poles of the magnet. The magnet is then moved to and fro through the material or substance containing the iron or steel particles, which particles are drawn to the poles in accumulations of more or less extent according to the strength of the magnet produced by the passing current. After a sufficient quantity has been gathered upon the ends of the magnet it is removed to a place of deposit, and upon releasing the push-button and breaking the current the particles will drop away immediately from the magnet. By repeating the process a sufficient number of times every particle of iron or steel down to the finest dust will be removed from the substance to be cleaned.

Mr. George N. Eastman, of Chicago, Ill., has patented new means for measuring electric currents. He provides a sensitive measuring instrument, preferably in the form of a sensitive potential measuring device, such as a millivoltmeter, and he also employs a compensating device, with which the measuring instrument is connected in shunts with the conductor carrying the current to be measured. The compensating device is closely associated with the conductor carrying the current, and has a very high resistance as compared with the resistance of



MEANS FOR MEASURING ELECTRIC CURRENT.

the measuring instrument. The points in the conductor where connection with the instrument and compensating device is made, are arranged suitably distant from one another in accordance with the capacity of the instrument and the resistance of the same and of the compensating device, these points being desirably as far apart as possible, to secure greater accuracy. By this arrangement the compensating device, which is closely associated with the conductor, varies in temperature just as the conductor varies. In other words, the temperature of the two is always the same, and, as a result, the resistance of the conductor and compensating device will vary correspondingly. Variations in temperature will, therefore, not disturb the relative resistance between the compensating device and conductor, and inasmuch as the resistance of the instrument is very small as compared with the resistance of the compensating device, the error of the instrument is exceedingly small, so small as to be negligible for all practical purposes. As a convenient arrangement, the compensating device can consist of a coil or length of fine wire of either the same material as that of the conductor of a different material. It is desirably of such material as to have the same heat coefficient as the conductor.

Reviews of Current Engineering and Scientific Literature.

Overlapping in Scientific Societies.

In his recent address before the British Physical Society, the president, Dr. R. T. Glazebrook, called attention to the overlapping of the work of the scientific and technical societies, and suggested that consideration be given to the matter to avoid this if possible. He first said that the growth of the Physical Society had not been what it should have been the last few years, and thought that this was due to the fact that technical science has proved more attractive. The work of the society has also grown narrower in the last few years, while papers were presented before the technical societies which were of purely physical character. He suggested that matters might be improved by printing and distributing papers before the meetings, as this was the only way in which a satisfactory discussion could be secured. Moreover, the rules of the society prevented the publication of more than a brief abstract of any paper in the technical journals, and this naturally prevented a desirable wide circulation of scientific studies. Other reasons for the unsatisfactory growth of the society, he said, were the need of a suitable home and the unsatisfactory hour at which meetings were called—5 P. M. This prevented the presence of many persons engaged in industrial work.—*Abstracted from the Electrician (London), February* 20.

The Locating of Short-Circuits on Concentric Mains.

Mr. Arthur T. Cooper here gives an account of a recent experience which he had in locating a dead short-circuit on a 400-volt direct-current feeder. The cable is lead covered and armored. It is about 1,000 yards long, has a cross-section of 0.4 square inch. As no other heavy cable was available for a loop test, the following tests were made: A bridge test, using one of the pilot cables and a stretched wire resistance to complete the bridge, the other pilot wire being used as galvanometer lead. The result showed the fault of twelve yards from the station. The resistance of cable from each end was then taken by fall of potential, and the resistance of the fault was allowed for. The result showed the fault 863 yards from the station. The telephone method was applied, and a distinct result obtained at 914 yards from the station. The fall of potential was then taken, the joint box being opened a short distance from the station. The result showed the fault 680 yards from the station. Next, the ohmic resistance test was taken by running a dynamo on the fault and taking volt-ampere readings with a heavy current flowing. No allowance was made for the resistance of the fault, and the results show that the break was 915 yards from the station. As this last test and that where the telephone was used agreed, the cable was opened at the point indicated, and the fault was found. It was thought that the results of these tests indicate that in locating faults several methods should be used before opening the cable. —*Abstracted from the Electrical Times (London),* February 19.

Standards for Electric Supply Mains.

The Cable Makers' Association of Great Britain has issued new standards relating to underground electricity supply mains, the data for which are given in tabular form in this article. These tables give the number and diameter of the conductor strands, the calculated and maximum allowable resistance, dimensions of the dielectric between conductors and the outside sheathing for various potentials and various types of cable. An increase of five per cent in the resistance of the cable is permissible over the calculated value. The resistance of each conductor of a twin or multi-core cable will be two per cent higher than that of a single cable for the same area. These standards also specify the voltage at which cables shall be tested, both before and after laying. Thus, a cable, if working on a 500-volt circuit, must be tested at 2,500 volts for fifteen minutes at the shop if the insulation is paper, and at 1,500 volts for the same time if jute insulation is used. After being laid, both styles of cable must be tested at 1,000 volts for one hour. Cables for high pressure must be tested at the following voltages:

Working Pressure. Volts.	Test at Shops. Volts for 15 Minutes.	Test When Laid. Volts for One Hour.
2,000	10,000	4,000
3,000	12,000	6,000
6,000	20,000	12,000
10,000	30,000	20,000

It is permissible to use these cables at voltages ten per cent in excess of those specified. The allowable variation in thickness of dielectric at any point is ten per cent below the standard minimum thickness. Standards are also given for the diameter of the galvanized steel armored wires for cables of various diameters.—*Abstracted from the Mechanical Engineer (London), February* 21.

The Osmium Lamp.

Some interesting figures are here given by M. Remane, of tests with osmium lamps in Berlin. In this installation there are about 300 lamps which have been in use for ten months. The lamps have been burning 800 hours and show no diminution in candle-power, the consumption of energy being 1.5 watts per candle. Tests have also been made by the German Society for Incandescent Gas Lighting, which give the following figures:

	Voltage. Volts.	Intensity Luminosity. Candles.	Watts Per Candle.
Commencement of the test.....	39	33	1.54
At the end of 500 hours.....	39	32.4	1.4
At the end of 1,000 hours.....	39	31.7	1.5

These lamps were fed directly from the Berlin lighting system by means of a transformer, and have been subjected to all the variations in potential of the circuit. Tests showed that the mean life of these lamps was about 900 hours. Three other tests have been made, which give results as satisfactory. Lamps manufactured for thirty-eight volts and thirty-two candles can be submitted to a voltage fifty per cent in excess of this without blackening, the energy increasing by one-half watt per candle. If the voltage is increased by sixty or seventy per cent, the lamp apparently does not deteriorate. The luminous intensity rises to about 400 candles, and the consumption of energy falls to about 0.3 watt per candle; but the life of the lamp is considerably reduced. The voltage may, however, be increased twenty per cent without the least deterioration. The disadvantage of the lamp is that it can not be used on direct-current circuits unless connected two or more in series, because of the low potential. On alternating circuits the necessary potential may be obtained by means of a transformer or a reactance coil, the latter method being preferred. It is stated that the price of the lamps is slightly over $1.—*Abstracted and translated from l'Électricien (Paris), February* 21.

Electric Power Transmission at Arbroath, Scotland.

An interesting electrical installation is being made in the textile mills of Andrew Lowson, at Arbroath, Scotland, which is here described by R. D. Munro. This company owns six mills, situated in different parts of the town, and previous to the alterations now going on, had separate steam plants in each building. The engines were of the beam type, and power was transmitted from main shafts through bevel gears and upright shafts to the various floors in each factory. These old plants are now being taken out, and a main power station for all six buildings has been constructed. Due to local conditions, it was found impossible to place the station centrally, and it was therefore located at one end of the group of buildings. The station will contain six Lancashire boilers, and is located conveniently for coal and water supplies. The engine room contains two compound engines of the Willans type, each of 825 indicated horse-power, and each having three cranks. These receive steam at 145 pounds per square inch, and run at 270 revolutions per minute. Each drives directly a 600-kilowatt Schuckert, 530-volt generator. The switchboard is quite simple and contains but three panels. The main feeder cables are run from the generating station in two six-inch cast-iron pipes. There are four single-core, paper-insulated cables. The pipes are carried partially on brackets fastened to the external walls of the several mills, and partially in a three-inch cast-iron pipe laid a foot below the bed of the stream running past the several buildings. The total distance from the power-house to the furthest mill is 470 yards. The removal of the old engines left ample room for installing the motors. These vary in capacity from 45 horse-power to 150 horse-power, and are belted to the countershafts. In the spinning mill a variation in speed is necessary, and here the motors have been provided with shunt regulators, allowing a change of about ten per cent. In certain of the mills it was necessary to enclose the motor in dust-proof boxes. These are arranged above the floor so as not to interfere with passageways, and are ventilated by pipes drawing air from the outside of the building. The motors are provided with oil-cooled starting boxes. Lights for the buildings are supplied by a thirty-kilowatt motor-generator set, and 105-volt lamps are used. One generating set has been operating for about twelve months, and has given satisfaction in every respect as to fuel, economy and steadiness in running, while the advantage of steady running in this industry is alone sufficient to justify electrical operation, irrespective of other economies incidental to this method of driving.—*Abstracted from Engineering (London), February* 13.

The Contact Resistance of Carbon Brushes.

M. Bourguignon has made an exhaustive study of the contact resistance between carbon brushes and commutators. The study was divided into two parts. The first is an attempt to determine the best conditions of operation, and the second to determine the best quality of carbon for various conditions of pressure, speed and current density. To measure this resistance, a special brush was attached to, but insulated from, one of the brush-holders. This rested on the commutator in a position beside one of the brushes in use. Between this exploring brush and the collecting brush a voltmeter is connected, contact to the collecting brush being made through insulated springs at the top of the brush, so that errors due to the resistance of the brush were eliminated. It was assumed that the resistance of the copper segments of the commutator was negligible. To avoid errors due to a distorted field, the armature was driven by an auxiliary motor; and to simplify the work, the fields of the machine under test were separately excited. To determine the pressure upon the collecting brush a small current was passed through this with the armature stationary. Then by attaching a spring balance to the brush and pulling up on this until the brush just left the surface of the commutator—which was indicated by the appearance of a spark—the pressure was accurately measured. Tests were made for varying speed, varying pressure and varying current density, other factors remaining constant in each case. The results of the tests are given graphically. These show a decreasing resistance as the current density increases, and an increasing resistance with an increase in the speed, the values varying from one ohm per square centimetre, and over, to about 0.05 of an ohm per square centimetre. The resistance decreased with an increasing pressure. An attempt was made to determine that brush pressure which would give the least commutator losses. As the resistance varies inversely with the pressure, but the friction losses vary with the pressure, there should be one point at which the sum would be a minimum. Curves are plotted to illustrate this, and it is shown that the proper pressure is that at which the tangents to curves representing the Joule loss and the friction loss have equal inclinations to the axes. Ten samples of brushes were experimented with, some being copper-plated, and others not plated. The results of the work indicate a value of resistance considerably less than that given by Arnold.—*Abstracted and translated from the Bulletin de la Société Internationale des Électriciens (Paris), January.*

Radio-Activity of Ordinary Materials.

It is well recognized that air in an ordinary vessel possesses the power of conducting electricity, although to a slight extent. The subject has been investigated by Mr. R. J. Strutt, and he has found some interesting results. This effect has been referred to as the spontaneous ionization of the air, which suggests that the conductivity is in some way an essential property of the air. It has been found that when a large vessel is used the amount of ionization is not proportional to the pressure, but tends toward a limit. This is exactly the behavior that might be expected if the effect was due to a feeble radio-activity of the walls of the vessel. The author has carried out a series of experiments to decide this question, with vessels constructed of various materials, among others, tin-foil, copper, lead, glass, platinum, aluminum, etc. These materials were made into cylinders thirteen centimetres in diameter. A central wire, charged and connected to an electroscope, formed the leaking system. The electroscope was exhausted, and the insulation was tried before each experiment to prevent leakage at other points. The results show marked differences in the rate of leakage when different materials constitute the walls of the vessel. This seems to indicate that the greater part, if not the whole of the observed ionization of air, is not spontaneous, but due to Becquerel rays from the vessel. It was noticed that the rate of leak, although constant for samples taken from the same stock, varied with samples of the same material taken from different stocks. The results were compared with the activity of uranium by placing a small crystal of this material within the cylinder. Results showed an activity for uranium, surface for surface, about 3,000 times greater than that of platinum; platinum giving the greatest results of any of the other materials tried. It is possible that this radio-activity of ordinary materials may be due to traces of more active substances, as only an infinitesimal portion of radium would be required. Radium is 100,000 times more active than uranium, so that one part of radium in 300,000,000 parts of platinum would suffice to account for the observed effects.—*Abstracted from Nature (London), February* 19.

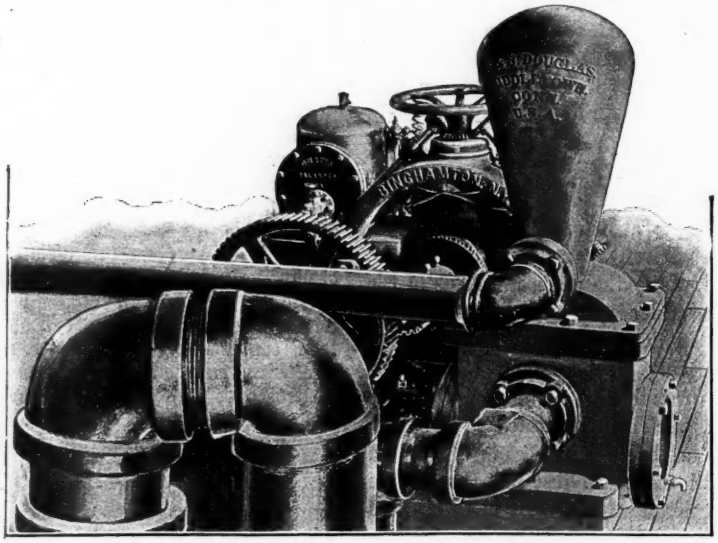
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Multi-Speed Motor Applications.

In the ordinary variable speed motor equipment it is sometimes found inconvenient to adjust the speed to the exact requirement of a particular case, the speed of the motor being governed by either a rheostat or controller, or some circuit-changing device, and the number of speeds obtainable depending on the number of contact points or steps in the controlling device. It is not possible to obtain a speed between each step, and in the case of variable speed motors operating power pumps, this is sometimes necessary.

The accompanying illustration shows a multi-speed motor, direct-coupled to a



MULTI-SPEED MOTOR, DRIVING POWER PUMPS.

power pump, the manufacturer claiming that any desired rate of speed can be obtained by the feature of control embraced in this system. In this way the rate of pump discharge can be regulated to suit exactly that required, by turning the hand-wheel on top of the motor. With this, as may easily be seen from the illustration, there is no auxiliary controlling apparatus, the machine being entirely self-contained, the motor driving the pump with a large rawhide pinion gear.

This motor is made by the Stow Manufacturing Company, of Binghamton, N. Y., the control system of which is well known. Among the advantages which the manufacturer claims for this motor is that of uniform efficiency throughout the entire range of speed, this being practically as high at one end of the speed range as at the other. This motor is well adapted to the individual driving of machine tools.

Electric Power Equipment for the Osaka Military Arsenal, Japan.

One of the most complete and up-to-date electric power plants recently installed in Japan is located at the Osaka Military Arsenal. This installation was made for the purpose of operating the electric cranes and blowers for the cupolas in the new foundry just completed. The foundry is built of red brick, with a corrugated iron roof, the inside dimensions being 86 metres 300 by 33 metres 400. It is equipped with four 10-ton, one 25-ton and one 20-ton Morgan cranes; also four 4-ton and six 7-ton cupolas, two being made by the Whiting Foundry Equipment Company, and the others in the arsenal itself. Four Root blowers, each driven by a Westinghouse forty-horse-power, type "C" induction motor, supplying the blast for these cupolas.

The power-house is equipped as follows: In the boiler room are two Sulzer-Frere Cornish shell boilers, centre-fired, each having heating surface of sixty-two square metres and a grate surface of 1.8 square metres. Each boiler is complete with its own heater, consisting of two plain cylinders, each of 600 millimetres diameter and of the same length as the boilers. These heaters are mounted over the boiler shells and suspended from the angle irons supporting the brickwork. One Worthington duplex pump and one restarting injector are provided for supplying feed water to the boilers.

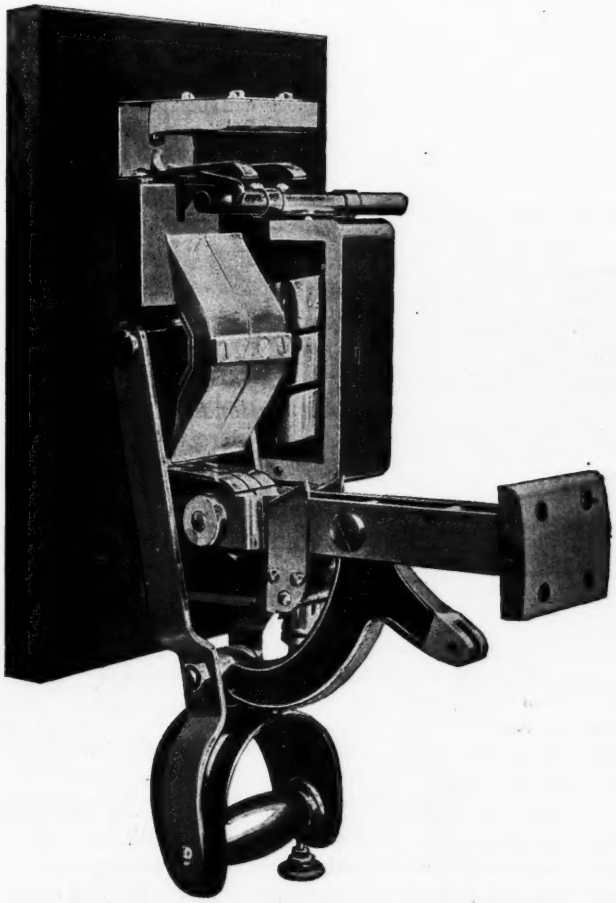
In the engine room there are two Sulzer-Frere vertical, tandem-compound, single, balanced-crank engines with high-pressure cylinders, 325 millimetres in diameter, low-pressure cylinders 475 millimetres in diameter and stroke 300 millimetres, operating under a steam pressure of eight atmospheres at 257 revolutions per minute. The low-pressure cylinders have a fixed cut-off, and the high-pressure cylinders a variable cut-off. Each engine is provided with a heavy fly-wheel, by means of which the angular variation of the engine speed is reduced to a minimum. The condensers are a part of each engine, operating from the crank-shaft by eccentrics.

Direct coupled to each engine is a Westinghouse 100-kilowatt, 220-volt, 3-phase, 3,600-alternation, composite-wound generator of the two-bearing, revolving-armature type and standard construction. The armatures are of the slotted drum type, the cores being built up of laminated sheets of steel pressed on the cast-iron spider and held in place between two end-plates. The armature windings consist of strap-wound coils formed and insulated before being placed in the slots, the coils being held in the slots by retaining wedges of hard fibre, thus requiring no bands. Two 11¼-kilowatt, 125-volt, multipolar exciters, driven by belt from the main engines, furnish field current for the separate field of the generators, each exciter having sufficient capacity for two generators. The switchboard, to which the two generators are connected in parallel, is of the Westinghouse standard type "8" construction. There are two 3-phase feeders, of 0000 B. & S. gauge each, leading out from the power-house to a distribution panel located at a convenient point in the foundry from which the circuits of the various cranes and blowers are supplied. Before any load was put on the generators they were synchronized, and it was noted from the ammeters and tachometers that there was no perceptible angular variation in the engine speeds and no cross-currents flowing between the armatures. As it was not possible to get a steady motor load, the generators were given a trial run on a non-inductive load. This load was obtained by rigging up three water barrels with iron-plate terminals, three plates being fastened at the bottom of the barrels and the other three lowered into the water by pulleys overhead. The artificial load thus secured provided an excellent means for properly adjusting the com-

pensating field for perfect parallel operation and for taking care of the full range of the machines. After this test a full-load run of two hours was made with the cranes and blowers working.

The cranes are all equipped with Westinghouse, type "C," variable-speed induction motors and Westinghouse crane controllers. The very close regulation of the motors and the perfect control of the cranes were subjects of much comment by the directors of the arsenal.

The design of the power-house and foundry, together with the layout of all machines in the latter, came directly under the supervision of Mr. G. Kuwada, the mechanical engineer of the arsenal. The foundry is a model of completeness in every detail and reflects great credit upon Mr. Kuwada, who is one of the most clever engineers in Japan. All of the electrical apparatus, as well as the cranes, blowers and two cupolas, were supplied by Messrs. Takata & Company, who are the sole agents in Japan for the Westinghouse Electric and Manufacturing Company.



CIRCUIT-BREAKER FOR OVERLOAD OR SHORT-CIRCUIT.

Circuit-Breakers.

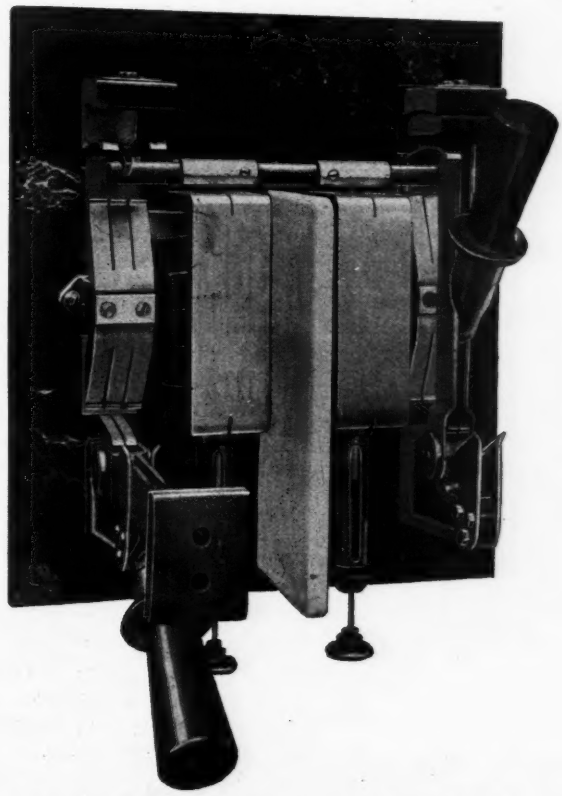
The circuit-breaker designed to open the circuit on an overload or short-circuit must of necessity be absolutely reliable and certain in its operation. The use of laminated contacts introduces a large factor of safety into this operation, but there are other features which are almost equally important; for example, the latch-holding device is an important one.

One of the difficulties of designing a satisfactory latch is in making it as frictionless as possible. Appreciating this point, the manufacturer of the apparatus shown in the accompanying engravings adopts a form of roller latch as being the one most promising to accomplish the desired result.

This latch is built up of laminated tool steel, which, after being securely riveted together, is accurately machined and hardened and then ground in a special fixture to the exact arc of the circuit in which its engaging surface moves over the roller.

The roller is made of tool steel hardened and ground. It is therefore held closed with certainty, and can be released upon an overload occurring with a minimum amount of energy of the magnetic portion of the circuit-breaker.

In addition to the latch being made as above, it is also provided with a small lever pivoted thereto, which increases its sensitiveness at the time of the overload or short-circuit, and yet at the same time does not introduce any uncertainty of the circuit-breaker flying open when it is operating normally, without an excessive flow of current.



CIRCUIT-BREAKER FOR OVERLOAD OR SHORT-CIRCUIT.

This construction enables this circuit-breaker to open not only on a short-circuit, but also on the least overload. If the core of the solenoid, which actuates the latch, is raised to its uppermost position, so that it can impart no hammer blow whatever to the latch, it is stated that this circuit-breaker will open at currents amounting to, or less than, the normal current for which the circuit-breaker is intended to continuously carry.

This sensitiveness of the latch is therefore of vital moment, as there are conditions found in practice in which the core of the solenoid will be started in its upper travel by an overload, and the amount of current may drop gradually as the core of the solenoid rises, in such a manner as to prevent the core hitting the latch with a hammer blow effect at this limit of travel.

This circuit-breaker is made by the General Incandescent Arc Light Company, New York city.

A New Wire Shade-Holder.

In the accompanying illustration is shown a new form of shade-holder which is claimed to be rapidly gaining ground in the electrical field. One of the principal features of this shade-holder is its simplicity and rigidity. It being very flexible, the shade does not suffer from vibration, and the attachment is made with the greatest ease. The holder affords four points for support, and is attached by opening the clamp as may be seen in

OPEN CLASP AND SLIP PRONGS UNDER LIP OF SHADE.

the illustration, spreading the prongs of the holder, passing it over the rim of the shade and then pinching the prongs together and slipping over the clamp. This holder is made by the Jem Shade-Holder Company, 503 Fifth avenue, New York city.

The Engineering College of the University of Illinois.

There are now more than 600 students at the engineering college of the University of Illinois, the attendance having more than doubled in three years. The demand for its graduates is greater than the supply. This increase in attendance has overcrowded many departments there, and immediate relief is necessary. The capacity of the foundry and forge shop should be more than doubled. This can only be done by the erection of a new building and adding more equipment. The engineering building is also overcrowded, as there is a serious lack of recitation and draughting rooms. To relieve this it is suggested that a new building be constructed for the use of the department of physics, leaving the rooms now occupied by the physical department for the engineering departments. The matter is now before the Illinois Legislature, asking for a liberal appropriation to carry out these plans. Illinois is the third state in regard to manufacturing industries in the country, and can not only afford a generous appropriation for the carrying on of technical instruction at the state university, but can not afford to neglect this important work.

New York Electrical Society.

The 233d meeting of the society will be held in the lecture room of the American Institute, 19 West Forty-fourth street, Wednesday, March 18, at 8 P. M. Professor R. H. Thurston will lecture on "The Steam Turbine to Date."

Professor Thurston is an authority on the subject of steam engineering, and his views on the subject of steam turbines will give the members of the society a definite and invaluable review of the actualities and possibilities of the situation. The course of the argument will comprise:

1. The beginnings of the steam turbine.
2. The fundamental ideas of its theory.
3. The turbine is not a thermodynamic machine.
4. The economies and the wastes of the turbine.
5. The present status of the machine in design.
6. Simple *vs.* compound turbines.
7. Performance of the turbine to date.
8. Opportunities for improvement.
9. Characteristic advantages.
10. Trend and promise for the immediate future.

The lecture will be illustrated by lantern slides.

Report of the Bureau of Equipment, Navy Department.

The annual report of the Bureau of Equipment, Navy Department, for the year 1902, gives a brief account of what has been done in wireless telegraphy by the department. The bureau has purchased two sets each of the Slaby-Arco, Braun, Siemens-Halske, Rochefort and Ducretet apparatus, and tests are now being made with these between the navy yard at Washington and Annapolis, Md. Arrangements have also been made for obtaining a duplicate set of the De Forest apparatus, but arrangements with the Marconi company have not been possible. The bureau favors government control of all wireless telegraph stations along the coast, and suggests legislation to this end.

The American Street Railway Association.

The twenty-second annual meeting of the American Street Railway Association will be held at the Grand Union Hotel, Saratoga Springs, N. Y., Wednesday, Thursday and Friday, September 2, 3 and 4, 1903.

Papers will be presented on the following subjects:

"Electric Welded Joints."

"The Evils of Maintenance and Champerty in Personal Injury Cases."

"Train Orders and Train Signals on Interurban Roads."

"Freight and Express on Electric Railways."

"The Manufacture and Distribution of Alternating Currents for City Systems."

"Comparative Merits of Single and Double-Truck Cars for City Service."

"The Right of Way."

An extensive exhibit of street railway supplies will be made at the hotel headquarters.

The annual banquet will be held on Friday evening, September 4, when the officers-elect will be installed.

The headquarters of the association will be at the Grand Union Hotel. No rooms will be assigned prior to April 15. Other hotels are the United States, American-Adelphi, Congress Hall, Worden and Kensington.

Railroad rates will probably be as in former years.

The National Electric Light Association.

The twenty-sixth convention of the National Electric Light Association will be held at Chicago, Ill., May 26, 27 and 28, 1903.

The headquarters of the association will be at the Auditorium.

It is expected that there will be a large attendance present.

Engineering Association of the South.

The transactions of the Engineering Association of the South have been received. This volume contains a number of papers, principally upon civil engineering subjects. A paper by T. F. O'Brien, entitled "The Engineer in Court," and another, by Mr. Alfred Hume, upon "Some Thoughts on Engineering Education," may prove of interest to electrical engineers.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ST. LOUIS LIGHT COMPANIES SOLD—The announcement that the Laclede Gas Light Company and the Missouri Edison Light Company have been purchased by the North American Company, of New York, has been confirmed. The price paid is said to have been $12,825,000.

VERMONT TROLLEY EXTENSIONS—Preparations are being made for the building of a system of electric railroads under charters granted at the last session of the Vermont Legislature to the Franklin County Traction Company, which, it is announced, will complete trolley connection between New York and Montreal. The new system will comprise seventy-two miles of track, with its connections, being the lines of the Burlington Traction Company and other roads now building in this state. Valuable water-power franchises have also been secured.

CAR EQUIPMENT FOR THE SUBWAY—The Interborough Rapid Transit Company, of New York, has awarded the contract for the electrical equipment of the trains on the underground railway. The General Electric Company received the order for the train control, which will be that of the Sprague-General Electric multiple unit system; this will be somewhat similar to that in use on the Manhattan Elevated Railway. The contract for the motors on the cars was divided between the General Electric Company and the Westinghouse Electric and Manufacturing Company.

THE BIDS FOR THE ELECTRIC SYSTEM IN MANILA—A syndicate consisting of Westinghouse, Church, Kerr & Company, J. G. White, of New York, and Charles Swift, of Detroit, made the only bid for the electric street railway and power franchises in Manila, under the tender specifications which were announced some time ago. The syndicate offered two and one-half per cent of the gross receipts for both franchises for fifty years. The German electric company which was interested in securing the franchises withdrew at the last moment, leaving the field open to the Americans.

LOUISVILLE LIGHTING DEAL—The transfer of the property of the Louisville Electric Light Company to the Louisville Lighting Company has been formally approved by the directors of the Louisville Gas Company. The transfer of the Citizens' General Electric Company having been ratified by the stockholders of that corporation, the merger of the two concerns is now practically effected. The directors of the gas company, which owns the Louisville Electric Light Company, have approved the transfer, according to which the property of the Louisville Electric Light Company is to be deeded to the new concern in consideration of securities paid to the Louisville Gas Company, consisting of $1,600,000 in bonds and $1,666,700 in stock. The Citizens' General Electric Company stockholders will receive $900,000 in bonds and $1,133,300 in stock. As the authorized bond issue of the company is $4,000,000 and the capital stock is $3,000,000, the terms of the consolidation provide that $1,500,000 in bonds and $200,000 in stock will remain in the treasury of the new company unissued.

CUBAN RAILWAY SYSTEM—An extensive electric railway system is to be constructed in Cuba. The project will be undertaken by the Insular Railway Company, Limited, which was incorporated last year under the laws of the state of New Jersey, with a capital of $2,500,000. The company is controlled by interests said to be identical with the Havana Electric Railway Company, which concern operates a thirty-six-mile electric traction system within the limits of the Cuban capital. The new lines will comprise four sections, making a total length of somewhat over 100 miles. The lines will all radiate from Havana. The first section will be constructed to Mariel, a popular seaside resort located about thirty miles in a westerly direction from Havana. The other lines will connect Congrejeras, Managua and Guines with Havana. The new system will handle both freight and passenger traffic. The contract for the rails—four feet by eight and one-half inches gauge—to be used in the construction of the Mariel branch has already been let to German mills. The entire Insular system will be operated by the electric power generator in the central station at Havana of the Havana Electric Railway Company. Sufficient machinery is at present installed in the Havana plant to furnish the necessary energy to operate the Mariel section, which is expected to be completed by July; but additional generating equipment will be needed in connection with the three other lines.

NEW JERSEY COMPANIES COMBINE—A certificate consolidating eight south Jersey gas companies under the name of the South Jersey Gas, Electric and Traction Company, has been filed at Trenton, N. J. The companies in the merger are the South Jersey Gas, Electric and Traction Company, the River Shore Gas Company, the Burlington Gas Light Company, the Bordentown Gas Light Company, the Gloucester City Gas Company, the Suburban Improvement Company, the Camden Gas Company, the Stockton Electric Light and Power Company, and the Beverly City and Township Gas and Water Company. The consolidated company has an authorized capital stock of $6,000,000, and, by the terms of the merger, is to issue at once $9,000,000 of bonds for the retirement of stock and bonds of the merged companies. The officers and directors of the company are: President, Anthony R. Kuser, Trenton; vice-president, William J. Bradley, Camden; secretary, Forrest F. Dryden, Newark; treasurer, Charles G. Cook, Trenton. Directors—Attorney-General Thomas N. McCarter, Uzal H. MacCarter, Newark; Barker Gummere, Jr., Henry C. Moore, Richard Stockton, Jonathan H. Blackwell, former Judge Robert S. Woodruff and State Treasurer Frank O. Briggs, Trenton; John J. Burleigh and Charles Watson, Camden; John L. Kuser, Bordentown; William J. Thompson, Gloucester; Herbert W. Johnson, Merchantville; Frank Berger, Elizabeth; Thomas C. Barr, Orange, and Stephen Peabody, New York.

LEGAL NOTE.

THE GILMORE SOCKET CASE—The General Electric Company announces that the suit against the Gilmore socket has been decided in its favor, and that an injunction will soon be issued. This suit was brought against Henry A. Truitt, trading under the name of the Imperial Electric Company.

OBITUARY NOTICE.

MR. WALTER A. HUSTON died at his home in Orange, N. J., on the evening of February 21, 1903. Mr. Huston was fifty years of age and was born in Pennsylvania. For the past fifteen years he was superintendent of the People's Light and Power Company, and of the United Electric Company, of Orange, N. J.

ELECTRIC LIGHTING.

RALEIGH, N. C.—Murfreesboro is to have an electric light plant, to be owned chiefly by M. E. Worrell.

TORONTO, ONTARIO—Berlin electors have passed the by-law for the purchase of the electric light plant at $80,000.

LAUREL, DEL.—The city council has decided to bond the town for $20,000 for the purpose of erecting an electric light plant.

HACKENSACK, N. J.—The Hudson River Line officials will enlarge their power-house to about twice its present size next summer.

NASHUA, IOWA—The city council of New Hampton has purchased for the city the electric light plant, paying $5,500 for the same.

TAMPA, FLA.—Edward DeLeon, of this city, will build an up-to-date lighting plant, plans and other specifications for which will be ready about March 15.

SENECA, MISS.—The citizens of Mountain Grove have granted a twenty-year franchise for an electric light plant to the Ozark Cold Storage Company, of that town.

LEOMINSTER, MASS.—It is stated that the Boston & Albany division is to be equipped with electric semaphore signals at every mile of the line between Boston and Albany.

JERSEY CITY, N. J.—The power-house of the Pennsylvania Railroad Company in this city was recently destroyed by fire. The loss is estimated from $70,000 to $100,000.

DIGBY, N. S.—The Bear River Electric Light and Power Company has in contemplation the extension of its plant to Digby, and toward Annapolis as far as Deep Brook.

BROOKLYN, N. Y.—Work is soon to begin on the immense power-house for the Long Island Railroad system and tunnel. The plant, it is said, will be the largest in the country.

FERTILE, MINN.—At a special meeting of the electors of the village it was voted to put in an electric light plant, to be owned and operated by the village in connection with the waterworks.

BOSTON, MASS.—Arrangements are being made to equip the Centennial-Eureka Mine with an independent electric lighting plant, with a capacity of 400 lights. The plant should be in operation June 1.

GALVESTON, TEX.—Edward C. Dowling and others have recently incorporated the Austin Light, Heat and Power Company with $2,500,000 capital, it is stated, and will rebuild the Austin dam. Gould interests are said to be behind the company.

SCHENECTADY, N. Y.—The plant of the Hudson River Power Transmission Company at Mechanicville, which supplies part of the power for the General Electric Company, is undergoing extensive improvements.

MEMPHIS, TENN.—The Memphis Light and Power Company has just completed improvements to its plant which double the capacity. The nominal horse-power is now 4,600, which can be increased to 6,000 if desired.

HARTFORD CITY, IND.—The Hartford City Lighting Company has transferred its electric lighting plant to Chicago capitalists, headed by George Mayer, of the Western Gas and Investment Company. The purchasers will further improve the plant.

UNION, ORE.—The electric power plant to be erected on Eagle Creek, east of Union, will be completed this summer. It is expected that 10,000 horse-power will be generated. The company will furnish light and power, and has already secured a franchise from the city council to do business in Union.

HOBOKEN, N. J.—The Jersey City, Hoboken & Paterson Railway Company, it is stated, will erect a new power station on Jersey City Heights, in which there will be machinery of capacity sufficient to run all the trolley lines in Hudson County. Other improvements are to be made, the entire work to cost in the neighborhood of $1,000,000.

ERIE, PA.—The iron ore and coal docks at Erie Harbor, owned by the Pennsylvania Company, will be equipped with an electric power plant in order to unload the boats and load cars more promptly. The plant will cost $27,000. The directors of the company have also authorized the erection of a power and electric plant at Cleveland, to cost $115,000.

WILMINGTON, DEL.—Negotiations which have been pending for some time have been closed, by which Wilmington's electric light plant passes into the hands of the United Water and Light Company, a corporation doing business under the laws of New Jersey, with a capital stock of $3,000,000. The plant was built ten years ago at a cost of $10,000, and was bid in by the new company for $12,000.

MIDDLETOWN, N. Y.—At the meeting of the stockholders of the Consumers' Light and Power Company, held recently, it was decided to accept the offer of the National Consolidated Company for the purchase of the former company's plant. A committee has been appointed to call on stockholders and obtain their assents to the sale, and a report will be made as soon as this work is accomplished.

GREAT FALLS, MONT.—It has been officially announced that the Marcus Daly estate has completed the purchase of the controlling interests in the Boston & Great Falls Land Company, the Great Falls Street Railway Company, and the Boston & Great Falls Electric Light Company. The purchase price amounted to over half a million dollars, and it is the intention of the company to invest about $75,000 more in improvements.

ONEIDA, N. Y.—John H. Robling, Niagara Falls, has completed maps and plans of the contemplated electric power plant located in the southwestern part of Stockbridge, on the Oneida Creek. The plan embraces two power plants of 1,000 horse-power each and about 500 feet apart, using the same water gorge. One of the plants will supply power to Oneida and Canastota exclusively, and the other to Syracuse. The cable will be carried by way of Peterboro and Cazenovia. The water privilege covers both sides of the stream and runs back about one mile.

DANSVILLE, N. Y.—The Mill Creek Electric Light and Power Company has been incorporated with a capital stock of $200,000, all of which is held by Dansville parties. The incorporators are: F. A. Owen, Dr. J. E. Crisfield, W. J. Beecher, B. G. Foss, J. H. Baker, F. J. McNeil and D. C. Cridley. Options have been secured on all the water rights on Big Mill Creek from a point above Stone Falls, and the dam will be constructed half a mile south of the latter. It will be twenty-six feet high, with a capacity of 8,000,000 gallons of water. The current generated will be sold throughout the village for power and lighting purposes.

SPARTANSBURG, S. C.—A new $100,000 concern, to be known as the Electric Manufacturing and Power Company, has been projected by a large number of local capitalists, for the purpose of developing water power on the French Brood River, thirty-five miles from this city and near Tyron, N. C., and at other points if desired. Among those named in the articles of incorporation are: John B. Cleveland, J. F. Cleveland, J. N. Cudd, A. N. Wood, C. R. Williard, R. R. Haynes, T. E. Moore, S. B. Tanner, W. S. Glenn, G. E. Ladshaw, W. E. Burnett, A. B. Grau and others. Formal organization will take place when fifty per cent of the capital stock is subscribed. The company has the right to increase its capital to $3,000,000 upon the authority of the board of directors.

PERSONAL MENTION.

MR. EDWARD F. PECK, Schenectady, N. Y., has been elected general manager of the Schenectady Railway Company.

MR. CLOYD MARSHALL, Chicago, Ill., has been appointed superintendent of electrical machinery in the department of electrical exhibits of the St. Louis Exhibition.

MR. W. A. KREIDLER, president of the Electrician Publishing Company, of Chicago, publisher of the *Western Electrician*, stopped in New York *en route* westward after a southern pleasure trip.

MR. EDWARD R. KNOWLES, the well-known electrical engineer, New York city, has been retained as consulting engineer for the Carnegie libraries for the Borough of Brooklyn. Mr. Knowles has also been retained as consulting engineer for the Massachusetts Portable Security Vault Company.

H. C. WILLIS.

MR. H. C. WILLIS retired from the American Steel and Wire Company on November 1, 1902, to accept the appointment as secretary and treasurer of the Hungerford Electric and Manufacturing Company. Mr. Willis was with the Washburn & Moen Manufacturing Company and the American Steel and Wire Company about ten years as manager of the insulated wire department in the New York territory. In this position Mr. Willis secured some very large contracts, several running considerably over $100,000. In addition to being an efficient sales manager, Mr. Willis has had some valuable experience as an engineer, having constructed a number of isolated plants and a small central station in the United States, and having erected a large central station in Puerto Cabello, in Venezuela, for W. H. Volkman, the American vice-consul. Mr. Willis has a host of friends in the electrical industry, and, as he is a salesman with a splendid record behind him, the Hungerford Electric and Manufacturing Company is to be congratulated upon thus securing his services. The company is nearly ready to place its product on the market. This consists of a complete line of insulating material for underground, overhead and marine conductors. The company owns a fine factory at Belleville, N. J., which is being rapidly equipped with modern machinery and appliances.

ELECTRICAL SECURITIES.

The past week has been a remarkable one for the extremes to which prices have sagged, then rallied, showing a distinct decline at the closing. While the financial districts have for some time conceded the ultimate defeat of the Aldrich bill, which was considered somewhat of a leading measure, the disappointment is more or less keen. The unfavorable bank statement, showing a reduction in the surplus reserves on deposits of less than $1,000,000, had also a bearing disposition. While these conditions under ordinary circumstances might be taken as disheartening, the continued good reports of industrial earnings held up the general tone of securities. Prominent interests maintain the attitude of anticipating a steadily improving condition.

The heavy rains throughout the southern part of the country make it likely that the fear of a drought will be out of the question for spring work, and this, with the indications that early crop possibilities will be fairly good, materially strengthens the speculative outlook.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 7.

New York:	*Closing.*
Brooklyn Rapid Transit	65½
Consolidated Gas	209¼
General Electric	190½
Kings County Electric	225
Manhattan Elevated	140¼
Metropolitan Street Railway	135
New York & New Jersey Telephone	166
Westinghouse Manufacturing Company	211

A quarterly dividend of 1¾ per cent has been declared on the capital stock of the Manhattan Elevated Railway Company for the quarter ending March 31, 1903, as well as an additional dividend of one per cent from the surplus earnings of the nine months ending March 31, 1903, both payable on and after Wednesday, April 1, 1903. The transfer books will be closed from March 13 to March 25.

The Commercial Cable Company has filed its certificate of increase of capital from fifteen to twenty-five million dollars. George G. Ward, as chairman, and Albert Peck, as secretary of the meeting voting the increase, signed the certificate. A quarterly dividend of 2 per cent will be paid April 1, 1903, to stockholders of record of the company on March 20, 1903. The transfer books will be closed March 20 and reopened April 2. At the annual meeting of the shareholders of the Commercial Cable Company, the report showed the net revenue for the submarine cables and land lines to be increased $123,692.22 for the year. The net earnings, including the amount brought forward from the previous year, amount to $2,514,193.19.

Manhattan Elevated Railway carried 2,500,000 more passengers this January than a year ago, an increase of over 90,000 each business day, or of 1,300 carloads a day. To meet this increase in business the carrying capacity of the road has been augmented by 2,500 cars a day.

Boston:	*Closing.*
American Telephone and Telegraph	165
Edison Electric Illuminating	295
Massachusetts Electric	92
New England Telephone	137
Western Telephone & Telegraph preferred	99½

It is stated that the American Telephone and Telegraph Company's annual report will show for the year ending December 31, 1902, net earnings of about $10,000,000 after the payment of all expenses, interest and taxes. This sum is equivalent to about 9 per cent on the $109,685,000 stock at present outstanding.

Philadelphia:	*Closing.*
Electric Company of America	9
Electric Storage Battery common	75
Electric Storage Battery preferred	75
Philadelphia Electric	7⅛
Union Traction	46⅝
United Gas Improvement	108

Chicago:	*Closing.*
Chicago Telephone	154
Chicago Edison Light	155
Metropolitan Elevated preferred	82
National Carbon common	23
National Carbon preferred	94
Union Traction common	9½
Union Traction preferred	42

Directors of South Side Elevated have declared the regular quarterly dividend of 1 per cent, payable March 31. Books close March 21 and reopen April 1. The company's daily average of passengers carried for February is 88,516, a gain of 9,130, being 11½ per cent.

The Metropolitan West Side Elevated Railway Company's report for the year ended February 28 is as follows: Total receipts for 1903, $2,042,400 as against $1,753,300, an increase of $289,100; net earnings for 1903, $951,000, compared with $814,000 in 1902, an increase of $137,000; surplus, $115,000 for 1903, as against a deficit of $26,000 in 1902, an increase of $141,000. The road carried 39,548,223 passengers, being an increase of 5,637,435, the net gain for the year being over 16 per cent. Passenger totals for the last four years follow: 1903, 39,548,223; 1902, 33,910,790; 1901, 31,656,972; 1900, 29,542,256.

The National Carbon Company reports net earnings of $594,371 for the year ended January 21, 1903. Of this amount, $315,000 was paid in 7 per cent dividends on the preferred stock. The total assets are $10,324,028.

TELEPHONE AND TELEGRAPH.

BIDWELL, IOWA—The Bidwell Telephone Company has been organized and will build an exchange here.

LINCOLN, NEB.—The Arlington Telephone Company will build a central telephone headquarters at Arlington.

ALBANY, N. Y.—The Home Telephone Company will, it is said, build a line to Bloomingrove and Wynantskill, and thence to Troy.

NEWBERRY, S. C.—The local telephone system has passed under the management of the Bell company. Mr. Roland G. Spearman has been placed in charge.

CHENANGO FORKS, N. Y.—The right of way is being secured by the Bell Telephone Company for a line from Pitcher, Cincinnatus, Willet and Texas Valley to Marathon.

ROCHESTER, N. Y.—Rights of way have been secured through the town of Groveland for a telephone line, which will be constructed along the highway from Dansville to Geneseo.

DEFIANCE, OHIO—C. P. Shuter, of Evansport, has obtained a five-year lease on all of the county lines belonging to the Northwest Telephone Company, and will organize the Home Telephone Company.

RIVERHEAD, L. I.—The Baiting Hollow & Roanoke Telephone Company is to extend its lines to Mattituck as soon as the weather permits. The line will also be extended to South Jamesport, and may possibly go to Greensport.

BEDFORD, PA.—The Western Maryland & Hyndman Telephone Company has been organized, with the following officers: D. H. Reynolds, president, and U. G. Carl, secretary and treasurer. The line to Ellerslie is practically completed, and will be erected to Hyndman by April 1.

NEW YORK, N. Y.—At the annual meeting of the Chicago & Northwest Telegraph Company, held in this city recently, William T. Noonan, of Minneapolis, was elected president, and A. R. Brewer, of New York, secretary and treasurer. George B. Manning, of New York, was elected a director in place of A. R. Brewer.

BROOKLYN, N. Y.—It is stated that a new building, to cost in the neighborhood of $70,000, will be erected by the New York & New Jersey Telephone Company in Greenpoint. The Greenpoint central office serves Williamsburg, Greenpoint and Long Island City.

CHICAGO, ILL.—Contracts have been let for the partial construction of a new telegraph and telephone company's line to operate between Chicago and other western cities. It will be called the Continental Telegraph Company. The line will run on poles to the largest cities in Illinois, including Bloomington, Peoria, Springfield, Decatur, and East St. Louis. It will enter St. Louis through a conduit. The distance is 410 miles, and the building cost is estimated at $400,000. A line will also be built to Kansas City, and one to complete the circuit through to Sioux City, and to St. Paul, Minneapolis and Duluth. The Kansas City line will cost $600,000.

NEW INCORPORATIONS.

EVERETT, MASS.—Paul System Company. $50,000.

LEBANON, PA.—Central Heat and Power Company. $50,000.

DOVER, DEL.—The Pittsburg Financial Company. $1,000,000.

BRADFORD, OHIO—The Bradford Telephone Company. $20,000.

GATCHELVILLE, PA.—The York Eastern Telephone Company. $8,000.

NEW BRUNSWICK, N. J.—The People's Cooperative Telephone Company. $100,000.

ROCHELLE, ILL.—Ogle County Telephone Company. Increased from $60,000 to $100,000.

CHATTANOOGA, TENN.—Birmingham District Coal, Light and Power Company. $100,000.

DOVER, DEL.—The Laurel-Seaford Electric Light Company. Increased from $20,000 to $50,000.

BUFFALO, N. Y.—The Independent Union Telephone Company. Increased from $200,000 to $1,000,000.

WATERTOWN, N. Y.—People's Power and Light Company. $50,000. Directors: J. M. Carpenter, C. W. Simons and G. H. Smith.

TRENTON, N. J.—Central New Jersey Telephone Company. $100,000. Incorporators: Frederick J. Randolph, Bruce Bedford, Charles W. Wright.

MILWAUKEE, WIS.—Badger Telegraph and Telephone Company. $150,000. Incorporators: Charles C. Russell, H. J. Droppers and E. L. Richardson.

LITTLE ROCK, ARK.—The Walcott Telephone Company. $5,000. Incorporators: J. W. Seay, A. Bertig, J. L. Clements, L. J. Willockson and Jason Light.

GREENFIELD, IND.—The Hannah & Jackson Telephone Company. $5,000. Directors: John W. Jackson, Wm. H. Marsh, Coleman Pope and Charles H. Hannah.

PORTLAND, ME.—The Elliot Lighting Company. $25,000. Directors: Arthur F. Elliott, West Newton, Mass.; Walter L. Came, Boston; William M. Bradley, Portland.

BELLEVILLE, MO.—Marissa Telephone Company. $2,500. Incorporators: J. A. Hamilton, Henry Finger, R. S. Coulter, A. C. Elder, R. P. Jensen and A. J. Mathews.

INDIANAPOLIS, IND.—The Winona Telephone Company. $30,000. Directors: Samuel Tomlinson, Albert B. Diggs, William S. Daniels, R. A. Tomlinson and S. A. Tomlinson.

INDIANAPOLIS, IND.—The Harrison Township Telephone Company. $5,000. Directors: J. H. Horton, John Willen, Edison E. Aberholtzer, V. E. Brown and Levi L. Johnson.

FINLAY, OHIO—The McComb Home Telephone Company. $20,000. Incorporators: A. L. Fruchey, J. C. Bright, J. R. Shoop, F. A. Griffin, L. Cusac, R. O. Duval and L. E. Bierer.

LITTLE ROCK, ARK.—Pocahontas Light, Water and Manufacturing Company. $50,000. Incorporators: W. T. Avera, C. E. Pringle, P. H. Miller, W. T. Bispham, W. H. Brown.

COLUMBUS, OHIO—Collins & Mercer County Telephone Company. $80,000. Incorporators: G. E. Nungerter, C. G. Miller, Levi Young, E. G. Bungerter, J. A. Hoagland, F. Biersderfer.

ROCHESTER, N. Y.—Torrey Telephone Company. $5,000. Directors: Edward C. Gillett, Edward C. Nutt, Frank E. C. Spencer, Ezra B. Thayre, William Pulver, Charles F. Whitaker and Frank Kipp.

NASHVILLE, TENN.—The Watagua Electric Company. $50,000. Incorporators: A. M. Young, F. A. Stratton, John H. Bowman, W. C. Armstrong, S. C. Williams, Tate L. Earnest and Walter H. Bowman.

WHEELING, W. VA.—The Bellaire Electrical Company. $30,000. Incorporators: Joseph A. Armstrong, James W. Corbett and W. A. Smith, of Bellaire, Ohio, and Harry L. Hesse and Andrew Armstrong, of Wheeling.

ELECTRIC RAILWAYS.

ZANESVILLE, OHIO—The Zanesville Street Railway Company has let the contract for the proposed track improvements and extensions to its line. The work will cost $130,000.

YOUNGSTOWN, OHIO—A mortgage for $1,000,000 has been filed in the county recorder's office here by the Stark Electric Company, to the Savings and Trust Company, of Cleveland.

LISBON, OHIO—The Youngstown & Southern Railway Company, which is about to build an electric line from Youngstown through this city to East Liverpool, has increased its capital stock from $100,000 to $1,800,000.

DULUTH, MINN.—The Duluth-Superior Traction Company is planning extensive improvements to its street railway lines the coming spring and summer, which will cost in the aggregate a quarter of a million dollars.

DENVER, COL.—The Florence & Kenton City Electric Street Railway has filed a mortgage to secure $2,700,000 five per cent twenty-five-year gold bonds, and will build 125 miles of electric railway throughout the region.

ALBANY, N. Y.—The Lake Shore Traction Company has been granted authority by the Railroad Commission to construct an electric railroad fourteen miles in length, from Westfield to Silver Creek, Chautauqua County. The line may later be extended to Buffalo.

CLEVELAND, OHIO—Preparations are being made by the electric railway companies of Cleveland for improvements and extensions to be made this year. About thirty miles of new track will be laid. It is estimated that about $1,500,000 will be required for the work.

INDIANAPOLIS, IND.—The Huntington, Columbia City & Northern Traction Company has been incorporated with a capital of $50,000 to build an interurban line connecting the three towns. The officers are: John A. W. Kintz, president; Frank J. Heller, vice-president; Willis A. Jones, secretary, and Benton E. Gates, treasurer.

FRANKFORT, KY.—The Louisville, Anchorage & Pewee Valley Railway Company has filed amended articles of incorporation with the Secretary of State, changing the name of the corporation to the Louisville & Eastern Railroad, and increasing the capital stock from $350,000 to $1,250,000. Of this $350,000 is preferred, and $900,000 common stock.

ESCANABA, MICH.—The scheme to connect Green Bay, Wis., and Escanaba by an interurban electric road has been revived with indications of success. It is proposed to obtain the bulk of the necessary power by harnessing the Chappie Rapids on the Menominee River, five miles from Menominee, which it is estimated can be made to develop in excess of 4,000 horse-power.

MINNEAPOLIS, MINN.—The Twin City Rapid Transit Company, which controls all of the street railways in Minneapolis and St. Paul, and the three interurban lines connecting these cities, has issued its annual report for 1902, which shows an increase in the net earnings over the year 1901 of $223,518. The dividends paid were seven per cent on the preferred, and five per cent on the common stock.

HARTFORD CITY, IND.—The city council has granted the Oil Belt Traction Company a fifty-year franchise to operate an electric line in this city. The promoters of the enterprise are J. B. McGeath, of this city, and W. J. Houck and William Amsden, of Marion. The proposed line is to extend from this city to Alexandria through Matthews, Fowlerton and Fairmount. The line is to be completed within eighteen months.

TROY, N. Y.—All the property of the Mountain Lake Electric Railroad Company, in Gloversville and Johnstown, excepting the track, cars and machinery power-house, has been seized by the sheriff under an injunction of $17,000 in favor of Theodore Scheiss, of New York, treasurer of the company, and was scheduled to be sold at auction February 28. It is expected that the company will be reorganized on a new basis.

UTICA, OHIO—The company which owns the electric railroad between Shelby and Mansfield has increased its capital stock to $1,000,000, with a view of extending the system. From Shelby, the

plan is to extend to Norwalk, where it will have connection for Cleveland. From Mansfield, the line is then to be extended southward, parallel with the B. & O. to Mount Vernon, where it is expected to get a connection for Columbus.

ATLANTA, GA.—The Atlanta & Marietta Electric Railway has been organized with a capital of $600,000 to build an electric road connecting the places named. The incorporators are: D. B. Gray, J. D. Good, F. W. Montgomery and Nathaniel Haven, of New York; P. D. McCarley, of Fulton County; A. H. and A. T. Cox, of DeKalb County, and W. R. Power, P. W. Bone and J. L. Anderson, of Cobb County. The work will be pushed immediately.

LOUISVILLE, KY.—Articles of incorporation of the Louisville & Interurban Company have been filed in the county clerk's office. The capital stock is fixed at $500,000, and the stockholders given are T. J. Minary, J. B. Speed, Attilla Cox, John Stites, Harry Bishop, Clarence Daliam and J. W. Gaulbert. The new company proposes to operate lines in Jefferson, Shelby, Oldham, Bullitt and Spencer counties, and several different lines are contemplated.

CHICAGO, ILL.—Articles of incorporation have been filed at Springfield for the Southwestern Elevated Railroad Company. The principal offices are to be in Chicago. The company proposes to construct an elevated line to connect with the Chicago Junction Railway. The incorporators of the new company are: John A. Spoor, president of the Chicago Junction Railway, Frederick S. Winston, S. R. Flynn, James Miles and John D. Black. The capital stock authorized is $100,000.

BALTIMORE, MD.—The Cumberland Narrows Electric Railway Company has been chartered here with $20,000 capital. The road will run between the Baltimore & Ohio Railroad's depot at Cumberland and Narrows Park, two miles out, and will be part of the system being built by Pennsylvania capitalists through the Cumberland mining region. The incorporators are Judge B. H. Koch, of Pottsville, Pa.; Benjamin A. Richmond, D. James Blackiston, Richard S. Bell and Harry E. Weber.

PHILADELPHIA, PA.—To provide for improvements and proposed extensions, the stockholders of the Philadelphia & West Chester Traction Company have authorized the creation of a $600,000 mortgage, securing a similar amount of fifty-year four per cent gold bonds. From the bond issue a sufficient amount will be reserved to revive the present issue of $400,000 of five per cent bonds. The balance will be used to fund the floating indebtedness of the company and provide means for development.

HARRISON, ARK.—The Arkansas Traction Company has been granted a charter by the Secretary of State. The purpose of the corporation is to construct an interurban electric road between Harrison and Keener, both in Boone County, and Dodd City, Marion County, *via* Lead Hill and other towns. The incorporators are Thomas Helm, of Harrison, president; R. M. Fellows, of Harrison, secretary and treasurer, and C. Irving Page, of Rochester, N. Y., vice-president. The capital stock is $500,000, all of which has been issued. The proposed road will connect Harrison with the White River extension of the Missouri Pacific.

INDIANAPOLIS, IND.—The Indiana Coal Belt Traction Company has been incorporated with a capital of $100,000 for the purpose of building an electric line in Sullivan, Greene, Clay and Vigo counties, from Sullivan to Linton and Terre Haute. The line will pass through Dugger, Jasonville, Hymera, Shelburn, Farmersburg and Merom. The company will run passenger and freight trains, and will also furnish electric light and power to private consumers and cities along the route. The directors are Charles L. Davis, William H. Crowder, Cuthbert J. Sherman, James R. Riggs, Charles H. Edwards, Lafayette A. Stewart, Albert E. Hazelrigg, Dr. J. Terhune and Raphael T. Thralls.

SCHENECTADY, N. Y.—The Schenectady Railway Company has opened its line between Schenectady and Troy, and this stretch of road is now in regular operation. The running time from Schenectady to Troy is about one and one-quarter hours. Mail service has been inaugurated on each car, each carrying a mail box and closed pouches for the post offices. The mail boxes on the outside of the cars are for the convenience of those residents along the Troy road who can mail their letters in this way. At the regular meeting of the board of directors, the following officers were elected: President, Hinsdell Parsons; general manager, Edward F. Peck; secretary and treasurer, James O. Carr.

INDUSTRIAL ITEMS.

THE CENTRAL ELECTRICAL COMPANY, Chicago, is carrying a complete line of "Faries" shades and can make prompt shipments on large or small orders. A large stock of Duplex lamp guards is also on hand, and the company will be pleased to make quotations on these.

THE KUHLMAN ELECTRIC COMPANY, Elkhart, Ind., manufacturer of stationary induction apparatus, including transformers, potential regulators, auto-transformers, reactive coils and spark coils, is distributing an illustrated catalogue showing the construction of Kuhlman transformers. This will be sent to interested parties on application.

THE BUFFALO ELECTRIC CARRIAGE COMPANY, Buffalo, N. Y., will be pleased to send its 1903 catalogue, descriptive of its equipments, to prospective users of horseless carriages. These carriages contain several innovations in electric vehicles, and the perusal of this catalogue will be of interest to those wishing information in this line.

THE BROWN & SHARPE MANUFACTURING COMPANY, Providence, R. I., has just issued its 1903 catalogue. This will be found to be very complete and is divided into two sections—one for machine tools and the other for small tools. Each tool is carefully illustrated and described, and a great deal of information of practical value is found in this catalogue.

THE HENDERSON ELECTRIC COMPANY, Chicago, Ill., has placed on the market a practical boring machine of which it is the patentee and manufacturer. This boring machine is made of bicycle tubing, nickel-plated and polished, has ball-bearings, universal bit-holders and telescopes to four and one-half feet. Information will be sent upon request.

THE DOUBLEDAY-HILL ELECTRIC COMPANY, Pittsburg, Pa., has now completely installed and has every facility in working operation in its new eight-story building, 919 Liberty street. The company has taken an enormous stock into its new building, and will be enabled to make immediate shipments of orders of any magnitude of any kind of electrical supplies.

THE MECHANICAL BOILER CLEANER COMPANY, Chicago, Ill., proprietor of the Garrigus patents for boiler cleaners, will be pleased to send its new catalogue to users of steam boilers. This catalogue gives a good idea of the application of the Garrigus boiler cleaner, and is supplemented with a number of reproductions of testimonial letters from users of this apparatus.

THE I. P. FRINK COMPANY, 551 Pearl street, New York city, has recently completed the installation of its reflectors in the American Art Galleries, New York, also in the new galleries of the Drexel Institute in Philadelphia, and has just finished putting them in the delivery room of the Boston Library for the purpose of lighting Mr. Abbey's "Holy Grail" decorations.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, has placed on the market a new type of electric lamp, the feature of which is a spiral filament, anchored at the base and apex of a thin glass tube. This lamp has not yet been given a trade name, and the Shelby company advertises a bonus of $50 for the most appropriate name. Full information will be sent on request to the company.

THE JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., has just completed an order for 24,000 feet of wire rope. This will be used for rigging up the yacht now being built for the defence of the American cup. The rope ranges from one-half inch to one and three-eighths inches in diameter, and is composed of six strands, each strand consisting of nineteen wires twisted together.

THE MACKIE STEEL TUBE MANUFACTURING COMPANY, Hammond, Ind., and 166 East Lake street, Chicago, has joined interests with the Clifton Manufacturing Company, of Boston, for the manufacture of Clifton fireproof insulating conduit. This conduit has been on the market for a number of years and has the fullest endorsement of the Underwriters' National Electrical Association.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, 118 West Jackson Boulevard, Chicago, Ill., has just

issued a new catalogue, No. 16, which is intended for the widest possible use in the telephone trade. This catalogue contains about 500 illustrations of telephone specialties and supplies, and the company will be pleased to send it to any one who writes for it.

THE GOHEEN MANUFACTURING COMPANY, Canton, Ohio, is the manufacturer of a number of specialties for painting structural work. The latest publication of this company, entitled "Hitch Your Wagon to a Star," shows a number of installations where the carbonizing coating manufactured by this company has been used to great advantage. This literature will be sent on request to the company.

H. O. SWOBODA is now prepared to place on the market a complete line of knife switches, panel-boards and switchboards. Offices will be located at 277 Broadway, New York city, under the name of the "H. O. S. Engineering Company," which will take charge of all sales and all engineering work. A special department for the manufacture of this apparatus has been established at the works of the National Brass and Iron Works, Reading, Pa.

THE EWING-MERKLE ELECTRIC COMPANY, St. Louis, Mo., has been organized by N. W. Ewing, Milton Mill, W. S. Merkle and W. G. Brown. These gentlemen have recently been department manufacturers of the Western Electrical Supply Company, St. Louis, and have had a large experience in handling electrical trade. This company has recently taken the lease of a large building at 1106 Pine street, and will carry a complete line of electrical apparatus and supplies in stock.

THE COLUMBUS STEEL ROLLING SHUTTER COMPANY, Columbus, Ohio, manufactures steel rolling doors, shutters and partitions. These are for freight houses, round houses, piers, shops, car-sheds, elevator shafts, or wherever fire protection is an essential feature. These steel rolling doors allow of great convenience, and their great flexibility makes them capable of being quickly raised or lowered, at the same time affording superior protection against fire risk than wooden doors.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has been awarded an important contract for an equipment by the city of Columbus, Ohio. This equipment comprises 1,500 series alternating arc lamps, complete, and is to be arranged in twenty seventy-five-light circuits. The contract includes transformers, regulators, and the entire switchboard for the new municipal plant. The Western Electric Company is placing a number of these series alternating equipments throughout the country.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, in its March calendar card of its great men of science and engineering series, publishes a miniature of Charles Robert Darwin, together with a characteristic biographical sketch. In a small flier just issued, the Bullock company calls attention to two typical Bullock direct and alternating-current machines driven by water-wheels, and several letters of commendation from satisfied users with relation to this apparatus.

WILLIAM ROCHE, 42 Vesey street, New York city, has issued a small booklet entitled "Of Interest to Battery Users and Others." This shows the use of the gas or gasoline engine igniter, making and breaking mechanism, the Roche new standard double-pole plug, Roche's new standard "Autogas" dry battery, new standard spark coil, the Roche's dresser or night light, the Roche fire insurance electric light, the Roche gas lighter, standard flashlight, gas stove igniter, alarm clock, etc. This will be mailed upon request.

THE EUREKA ELECTRIC COMPANY and the Advance Electric Telephone Company, both of Chicago, Ill., have consolidated with a total capital of $150,000, and will remove to Genoa, Ill. Bids will be received for the erection of a two-story brick building, 96 by 225 feet, of mill construction. About forty new houses, required for employés and other buildings will be erected. E. C. Shippee, John Hadsall, Thomas Sager, all of Genoa, Ill., will supply information. The negotiations were conducted by Funk, Lawrence & Company, Security Building, Chicago.

THE LYON METALLIC MANUFACTURING COMPANY, 137-139 Fulton street, Chicago, has introduced a new specialty called the "Lyon" taper box. This is twenty-two inches by eleven inches at the top, eighteen by eight inches at the bottom, and six inches deep, being made from eighteen-gauge stock. The Lyon Metallic Manufacturing Company is a sheet metal working establishment, and has placed on the market a number of specialties for use in electrical workshops. Full information from this company will be supplied on request.

THE MURDOCK CORPORATION, Boston, Mass., will be the name by which the Murdock Parlor Grate Company will hereafter be officially known. This company's line of business has been extended in so many directions that the former name does not adequately cover its production. The manufacture has been broadened to include hard wrought-iron work, hard brass and bronze work, iron and brass goods of every nature, bronze tablets, marble composite stone, composite tile and silichite which is made in any color for exterior work. Mr. Samuel Shaw is the president of the corporation.

THE NATIONAL INDIA-RUBBER COMPANY will remove its New York offices to 9-15 Murray street. Mr. Henry D. Stanley will represent the wire and cable department. Important changes have also been decided upon at the mills of this company, at Bristol, R. I. The wire department is to be increased to an extent which will more than double its present output, and give full employment for 150 people. Three floors will be utilized in this extension, and, when the installation is complete, the National India-Rubber Company will be among the largest manufacturers of rubber insulated wires and cables.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., has just issued bulletin No. 11, describing its continuous light semaphore spectacle. The purpose of the continuous light spectacle is first to display the normal night indication whether "danger" or "caution" until the semaphore arm has traveled more than two-thirds of its arc toward the "clear" position. Second, to prevent the conditions of the clear night indication under similar conditions, and to prevent the complete eclipse of the signal light at any point of the transit of the signal from one indication to another. This bulletin will be sent to any one on request.

KILBURN, CLARK & COMPANY, Seattle, Wash., has been made the Pacific coast sales and distributing agent of the Nernst Lamp Company, Pittsburg, Pa. Branch offices have been established in San Francisco and Los Angeles, Cal. The increasing volume of business from that section of the country has made necessary this special attention. The Nernst Lamp Company, having secured patent and selling rights in Canada, is now making arrangements for establishing a factory in the Dominion for the manufacture of its product. This is necessary, not only to conform with the Canadian laws of commerce, but it is deemed advisable in order to meet the demand for lamps in this direction.

THE EASTERN AUTOMATIC TELEPHONE COMPANY, Boston, Mass., is in receipt of an interesting letter from the Westerly Automatic Telephone Company, of Westerly, R. I. This company opened its exchange for service in last October with seventy subscribers connected and ninety names on the list. The business has grown until now there are one hundred and eighty subscribers and two hundred names on the list, and the immediate prospect of this being increased considerably. In addition to pole lines throughout the town, the company is building five miles of line to Watch Hill, and has obtained the right to build to Noyes Beach, a distance of six miles, where connections will be made with lines to Narragansett Pier and Peacedale. The company has also secured rights to make other connections.

THE WESTON ELECTRICAL INSTRUMENT COMPANY, Waverly Park, Newark, N. J., has opened a New York office at 74 Cortlandt street. This office will be under the management of Mr. Caxton Brown, who has a theoretical as well as a practical knowledge of the different instruments manufactured by the Weston company, and their particular adaptabilities. There will be a showroom in connection with the New York office in which will be exhibited the different types of Weston instruments and their special advantages; also the individual parts which make up the instruments. Besides being a great convenience to customers, the New York office will eliminate much correspondence in the nature of enquiries, thus reducing time of delivery of orders. The Weston Electrical Instrument Company extends a cordial invitation to all interested in the subject of electrical measurements to make use of its New York office, either for the purpose of enquiry on the technical points involved or for the prospective purchasing of instruments.